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Five foot Radial Drill Press.

We give on this page an illustration of an improved radial drill, in designing which special pains have been taken to secure great stiffness and strength, and at the same time a range of speeds fitting it for drilling or boring holes from ¼-inch to 24 inches diameter. The bed plate of the machine is 8 inches deep, strongly ribbed, and is 7 feet long and 4 feet wide.

To this is secured a heavy sleeve, 8 feet high, into which the column is fitted, its weight resting upon 175 steel rolls, so that the arm is easily moved by one hand. It can be clamped in any desired position by the plain split ring or sleeve shown, which is clamped by a box wrench and holds the column very securely.

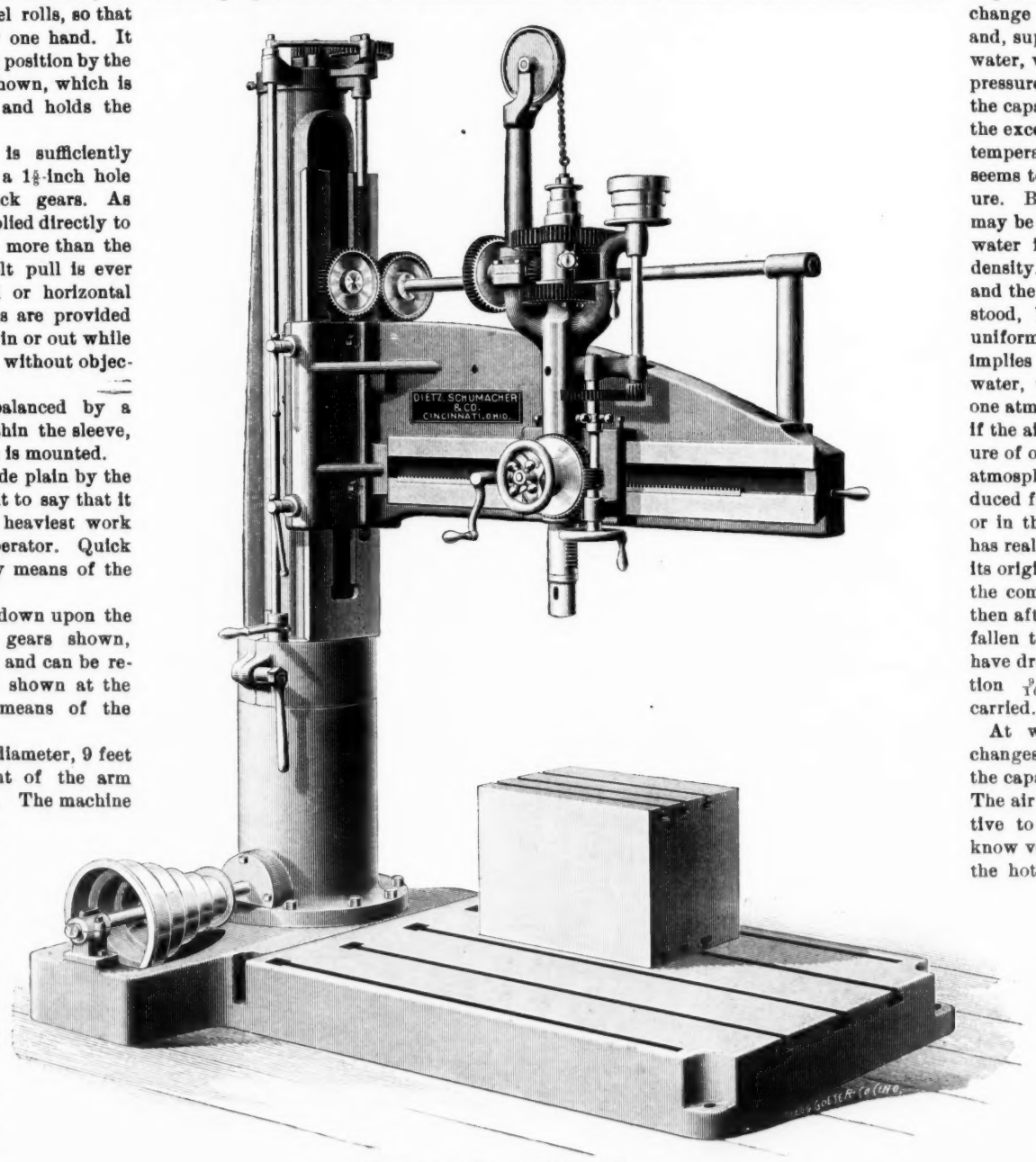
The driving mechanism is sufficiently strong and powerful to drill a 1⅛-inch hole in solid stock, without back gears. As shown, the back gears are applied directly to the spindle, so that nothing more than the twisting moment due to belt pull is ever borne by either the vertical or horizontal transmission shaft, and means are provided for throwing the back gears in or out while the machine is running and without objectionable shock.

The spindle is counterbalanced by a helical spring, which is within the sleeve, upon which the chain sheave is mounted.

The feed mechanism is made plain by the engraving, and it is sufficient to say that it is powerful enough for the heaviest work and is convenient for the operator. Quick return motion is provided by means of the hand wheel in front.

The arm is moved up or down upon the column by the screw and gears shown, which are driven by power and can be reversed either by the handle shown at the side of the column or by means of the countershaft.

The column is 16 inches diameter, 9 feet high, the vertical movement of the arm upon this being 30 inches. The machine receives, under the spindle and over the base, 5 feet 4 inches, and will drill to the center of a circle 120 inches diameter. Spindle is of steel, $2\frac{1}{16}$ inches diameter, bored to No. 4 Morse taper, and has 12 inches vertical traverse in the saddle. Cone pulley has 5 steps for a 3-inch belt, and the gearing with and without back gears respectively is proportioned 13 to 1 and 2 to 1. Countershaft with friction pulleys accompanies the machine. The machine weighs 7,500 pounds, and is built by Dietz, Schumacher & Co., Cincinnati, Ohio.



FIVE-FOOT RADIAL DRILL PRESS.

Generally speaking, in the instance of machines, the one with which the most work can be produced in a given time is the cheapest notwithstanding the cost. But this does not always follow. Suppose there is no use for such a tool for more than a month in the year the case requires further consideration. You do not need a horse that can do his mile in two minutes to draw a plow. A cheaper animal would probably be better in every way.

About the "Freezing up" of Compressed Air.

BY FRANK RICHARDS.

The most familiar and the most constantly reiterated objection to the use of compressed air is its well-known habit of "freezing up" under certain conditions, and too many who have not sufficiently investigated the subject have regarded this freezing up of the air as an insurmountable and fatal objection to its use for purposes for which it would seem to be otherwise eminently adapted. By "the freezing up of the air," as the expression is commonly used (although, of course, it is never the air that freezes), we understand a deposition of moisture, more or less rapid, upon the sides of the pipes or passages that convey the air and its accumulating and freezing there until the area of the channel is materially reduced, the proper flow of the air prevented, and the operation of the air motor or other apparatus seriously impeded or stopped entirely. This phenomenon may easily occur in the use of compressed air. The earlier experimenters in this line all encountered it, and most of them on account of it at once dropped compressed air as a practicable power transmitter, and the freezing up of compressed air has remained a formidable bugaboo among otherwise intelligent mechanics to this day. The best way to do in a case like this is, first of all, to have a good look at it all around in broad daylight. It would seem to be worth while to get together, where we can see them, the principal facts of the case, so that we may be able to understand the conditions under which the freezing up occurs, whether it must always accompany the use of compressed air, and, if not, the combination of conditions under which all danger of freezing up may be successfully avoided.

It is evident that for freezing up to occur two things are essential, and neither alone could have any effect toward producing such a result. The free moisture must be present and accumulating, and the temperature of the air where the freezing up is to occur must be below the freezing point. The moisture alone can cause no trouble as long as the temperature continues high enough. It will simply be carried along with the air and be discharged with it. So, too, a low temperature of the air in the passages at any time will not freeze up anything as long as there is no free moisture in the air at the time to be frozen.

We may say generally that air always contains moisture. Its capacity for moisture is determined by the combined conditions of pressure and temperature to which it is at the time subjected. Changes either of pressure or of temperature immediately change the capacity of the air for water, and, supposing the air to be saturated with water, whenever, either through increase of pressure or through decrease of temperature, the capacity of the air for water is reduced, the excess of water is dropped. At constant temperature the capacity of air for water seems to be inversely as its absolute pressure. By another mode of stating this it may be said that the capacity of the air for water is independent of its pressure or density. It is so stated by some parties; and the statement is correct if rightly understood, but is apt to be misleading. At uniform temperature a given volume of air implies a capacity for a certain weight of water, whether the air be at a pressure of one atmosphere or of 100 atmospheres; but if the air has been compressed from a pressure of one atmosphere to a pressure of 100 atmospheres, or if its volume has been reduced from, say, 100 cubic feet to one foot, or in that proportion, its capacity for water has really been reduced to one-hundredth of its original capacity, and if the air before the compression was saturated with water, then after the compression, and after it has fallen to its original temperature, it must have dropped somewhere during the operation $\frac{99}{100}$ of the water that it originally carried.

At whatever pressure the air may be, changes of temperature immediately affect the capacity of the air for carrying water. The air in this respect seems to be as sensitive to temperature as to pressure. We know very distinctly the general fact that the hotter the air, the greater its capacity for water; but there seem to be little satisfactory data as to the quantity of water that will be carried by compressed air under different conditions of temperature. The absence of such data, however, need not seriously cripple us in our quest.

In the operation of air compression, the heating of the air, and the increase of water capacity thereby, seems to keep pace with and compensate for the reduction of water capacity consequent upon the increased pressure, and we never hear of any trouble from liberated water in the compressor, but after leaving the compressor the water begins to make itself known, and all the world hears of it. As the air leaves the compressor it is usually quite hot, and even at the high temperature the air is saturated, or nearly saturated, with water. As the air cools, the water begins at once to be released, and before it is thoroughly cooled considerable water is generally deposited. Changes in meteorological conditions, or in the original

humidity of the air as it enters the compressing cylinder, of course, change the amount of water precipitated by the air after compression, and all who have experience with compressed air find that on this account the air carries and deposits more water at some times than at others.

In taking the air immediately from the compressor, and before it has been completely cooled, or, if cooled, in neglecting to drain all the liberated water from the pipes before using the air, is where many amateurs and experimenters have encountered trouble from the freezing up of the air. And when experience has offered them a lesson, they have too often misread it. When an air motor or an engine driven by compressed air "freezes up," usually by the choking of the exhaust passages, the general impression among mechanics is that the water is precipitated by the air at the moment when the freezing occurs; but the fact usually is that the water is deposited in the pipes by the air before the motor or engine is reached, and the water is then carried along as entrained water by the friction of the air, and when the temperature of the air falls below the freezing point, on account of its expansion in the cylinder or at the exhaust, the water, being present and in contact with the cold air, is of necessity frozen.

The general practice of the day in the compression and transmission of air does not seem to make adequate provision for disposing of the water. As the air leaves the compressor it is usually quite hot, and even at the high temperature it is saturated or nearly saturated with water. As the air cools it begins at once to lose its capacity for water, and some of the water is dropped and continues to be deposited as long as the air continues to cool. In connection with the compressor, and usually quite near it, a receiver or reservoir of considerable capacity is provided, the most important function of which is, or is assumed to be, that of collecting the water that may be precipitated by the compressed air. In too many cases this receiver fails of its mission, or only partially collects the water from the air, because, if the compressor is working constantly and rapidly, as they usually do, the air goes through the receiver and out of it and into the pipe line before it has time to cool. The air after compression will not drop all of its water until it is thoroughly cooled, and the cooler it gets the greater will be the quantity of water liberated, and when the air, still under full pressure, has reached the lowest temperature attainable, means should then be provided for collecting the liberated water, or it must, of course, be carried along in the pipes to make trouble where the air is used. With a receiver near the compressor, and with hot air passing through it, and a pipe line long enough to thoroughly cool the air before it is used in rock drill, air motor, pump, or other constantly running machine, and with no provision for disposing of the water, we should expect to hear of the machines freezing up. Cases are quite common where a second receiver placed at the farther end of a pipe line has effectually cured the freezing up by removing the congealable liquid.

A few years ago, many air compressors for driving rock drills were in use in the United States—a large number of them upon the New York aqueduct—which cooled the air during compression by the injection of jets of water into the air in the compressing cylinder. Compressors of this style are not now built by any firm. The cylinders were found to wear out quite rapidly, the compressors could not be run as fast as the dry compressors, and for other similar reasons they did not pay. They did, however, deliver the air decidedly cooler than the compressors now in use deliver it, and it is not surprising that it should be claimed by rock drill runners, and probably correctly, that those old injection compressors, with the water intimately mingling with the air during the compression, still furnished drier air, and, consequently, air less liable to "freeze up," than the more modern dry compressors furnish. When the air is completely saturated with water, contact with water will not make it any wetter. The water in the injection compressor did not wet the air, for it was as wet as it could be, and as that water enabled the compressor to deliver the air at a lower temperature than the dry compressor would deliver it, the air, simply because it was cooler, actually emerged from the compressor bearing less moisture than the air emerging at the same pressure from the dry compressor. If no means were provided for draining the surplus water from the air, except, in either case, the receiver located near the compressor, the cooler air would carry the less amount of water into the pipe line and through it; but if, in each case, after the air had traversed the pipe a sufficient distance to have become thoroughly cooled another receiver or drainage chamber had been provided there is no reason why, after emerging from the chamber, the air in each case being at the same pressure and temperature, the one should carry any more water than the other. To get rid of all trouble from water in the air, and the possible freezing of it, care should be taken that when the air passes a point where it is still at full pressure and has reached its lowest temperature, such means of drainage shall be provided that none of the liberated water shall be carried into and along the pipes beyond that point.

The possible freezing up that we have been contemplating thus far along in this article is where water is present by deposition from the compressed air, and where a low temperature is caused by the expansion of the air and freezing of the water ensues by contact. Another mode of freezing up is experienced where the freezing is accomplished not by the air that has been compressed, but by the external atmosphere. In the winter, if compressed air at low temperature, but still above freezing, saturated with water, as it is pretty sure to be, and with the pipe thoroughly drained to a certain point, has then to pass for some distance through a pipe exposed to a freezing atmosphere, it cannot fail to deposit some water, and the freezing of the water so deposited soon chokes the pipe. I have encountered cases of this kind more than once, notably in one of the largest chemical works of the country, where the pressure of the air is employed for transferring acids. The only apparent lesson in this case is to protect the pipe from frost. A pipe conveying compressed air, and exposed to a freezing atmosphere, is quite sure to choke up. The deposition of the water may proceed slowly, but if the low external temperature continues, the accumulation will eventually reduce the air channel, or even close it entirely. This result is, of course, chargeable to the weather and not to the supposed innate frigorific malignity of the air.

The pressure at which the compressed air is transmitted, and eventually used, has an important bearing upon the question of its freezing up in use. If the air is transmitted only short distances, and at low pressures, the probabilities of freezing up are much greater than if high pressures are employed, and if the distance of transmission is at least sufficient to allow of a thorough cooling and drainage of the air while under full pressure. In the use of low pressure air for any service, of course, a larger volume of free air is used to furnish a given power, and the larger volume of air implies the presence of a greater quantity of water in suspension, and the lower pressure employed affords less opportunity, or no opportunity, for extracting the water, and, as a fact of experience, most of the freezing up trouble that is actually encountered is from air that is used at comparatively low pressure.

There are many considerations, which we need not enumerate here, to commend the use of air at high pressures, and not the least among those considerations is the practical freedom from freezing up that is thereby secured. This may be readily understood. Say that air is compressed to 1,000 pounds gauge or, say, 70 atmospheres, either that smaller pipes may be used for long-distance transmission, or that smaller receivers may be used for the storage of air upon a street railway motor, and say that the air is admitted to the motor at 100 pounds. If, while the air is at the pressure of 1,000 pounds, it is thoroughly cooled and drained, it is evident that when that air is expanded to 100 pounds, and has been allowed to regain its normal temperature, that if the air was just saturated with moisture when at 1,000 pounds pressure and normal temperature, when it has expanded to more than eight times its volume, it can be only one-eighth saturated, and no water can possibly be deposited by it in expanding from 100 pounds downwards, and however low the temperature may fall, there can be no freezing up.

I have said nothing in this article about reheating the air before using. It is not necessary as a preventive of freezing, but, rather, is valuable as a means of increasing the volume of the air and the available power at slight cost.

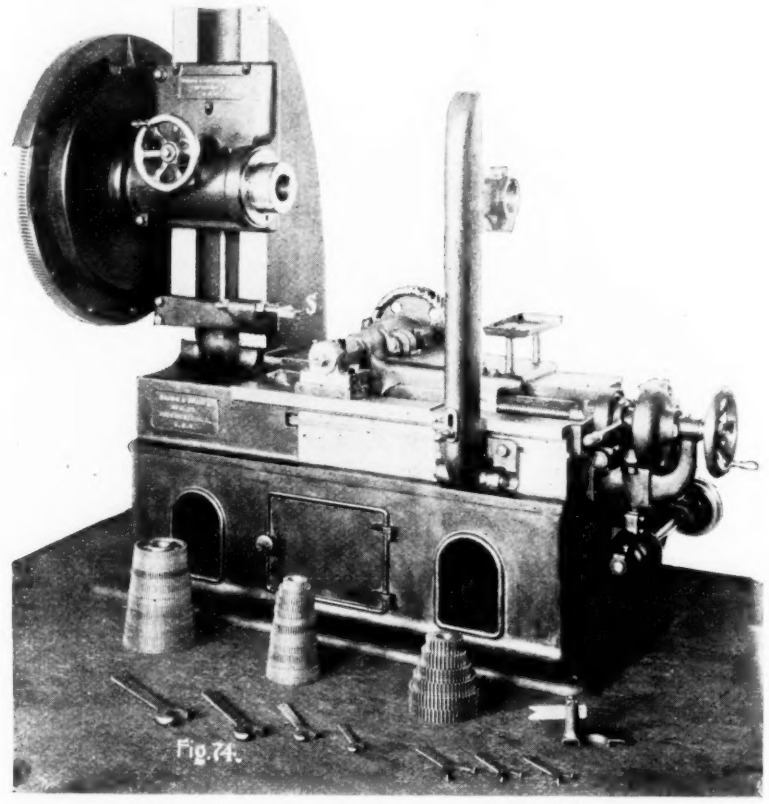


Fig. 74.

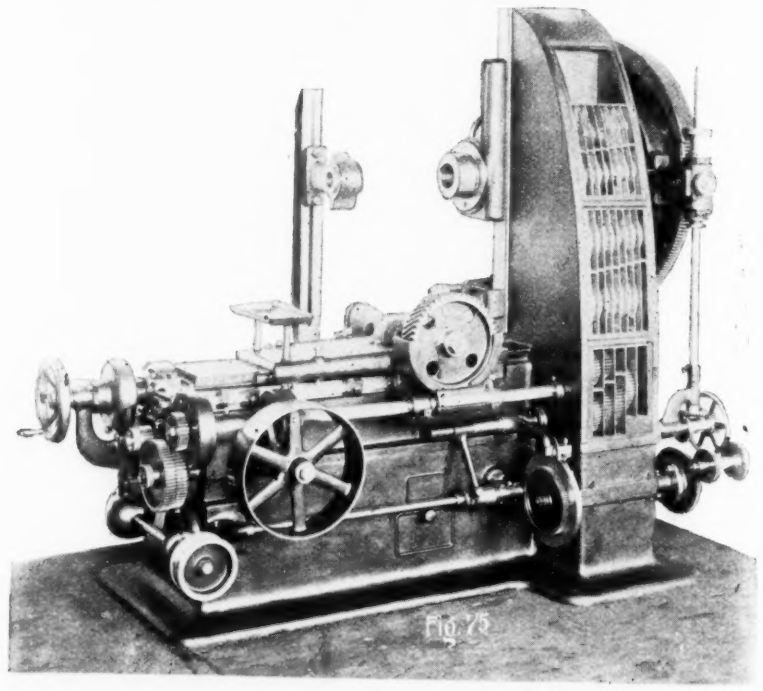


Fig. 75.

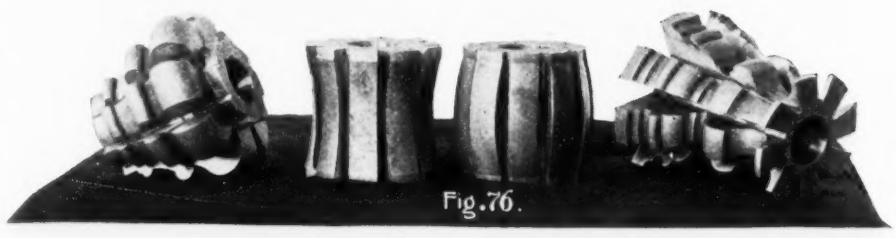


Fig. 76.

MACHINE SHOP MILLING PRACTICE.

Machine Shop Milling Practice.—IX.

BY HORACE L. ARNOLD.

The Brown & Sharpe automatic gear cutter is shown in Figs. 74 and 75, and made the following cut, to which I was eye-witness: in cutting a gear 3 diametral pitch, and 6 inch face, it cut several consecutive teeth without a pause at the rate of *two teeth per minute*. This gear blank was 20 inches diameter, to have 60 teeth, 6-inch face, and would have been cut inside of 30 minutes; the actual time of cutting one tooth and returning ready to cut the next tooth was 28 seconds. The machine worked easily and with perfect quiet and steadiness; it was impossible to believe that the cutter was removing a section of cast-iron over ½ of a square inch in area at the rate of about 18 inches feed per minute. Although Brown & Sharpe do not recommend this unprecedented rate of feed for their gear tooth cutters (this cut was made with one of their regular stock cutters), the mill was not heated nor dulled by its work, and the

chips did not seem nearly so hot as would be supposed. No one had any explanation of this performance to offer. It had been reached by simply putting up the feed far beyond what any one supposed could possibly be maintained.

"Except for the simple fact that the machine does do it, we *know* such a rate of cutting is impossible," said Mr. Viall, in commenting on this performance. "Had any one told us that anybody's machine or anybody's mills could make such a cut at such a rate, we would have been certain the statement could not be borne out by the facts."

This machine cut 12 hard cast-iron gears, 65 teeth, 3 pitch, 21⅔ inch pitch diameter, 4½ inches face, in less than 10 hours, ranging from 45 to 50 minutes time for each gear, including all putting in and taking out of the machine. There was also a memorandum in the books of the foreman of gear cutters of cutting the teeth in a pair of steel gears, 3 diametral pitch, 21⅔ inch pitch diameter, 65 teeth, 4½ inches face, feed 2 inches, and revolutions 19 per minute, cutter flooded with best lard oil, the two gears being toothed in 7 hours, including all handling and setting.

As will be seen from the engravings, the large B. & S. automatic gear cutter offers a radical departure in outline from the long-established design of a rectangular upright on which the gear blank carrying spindle is vertically adjustable, rising from a horizontal base, on top of which the cutter carrying spindle slides to and fro in its work. As shown, the base is very much increased, and is cast in one piece with the substantial upright, on one face of which the gear blank carrying spindle is located, and the space between the side webs of this vertical member is filled with wooden partitions so as to afford a convenient receptacle for the numerous change gears used in the automatic tooth spacing and tool carriage driving action of this machine. Another substantial upright is adjustably secured to the horizontal part of the frame and provided with a vertically adjustable outboard support for the blank carrying spindle; this gives a rigidity of blank support not before had in machines of this type, which is undoubtedly one of the most convenient forms in which a gear cutter can be organized.

The added horizontal base length is used to give a very long and low support to the cutter spindle, which, with the outboard support for the blank carrying spindle, enables the machine to cut a series of blanks at once, quite in the manner of the old "clock-wheel machines," and the blank support *S* is seated in a lug cast solid with a substantial cross bar clamped to the main upright. The automatic movements of the machine are obtained by beautifully smooth and prompt working actions, and the fitting is, I need not say after the record of performance given, of the highest class.

I omitted to state in speaking of the feat of cutting two 3-diametral pitch gear teeth, 6 inches long, inside of one minute, that the cut was made through the solid; not a re-cut following a blanking cut with a square face mill, as is often the case with a cut of so great a section. It was a clean job out of the solid, and no part of the machine showed the slightest sign of overtaxing, or of working up to its capacity. Everything was smooth and easy, as if no work at all was being done.

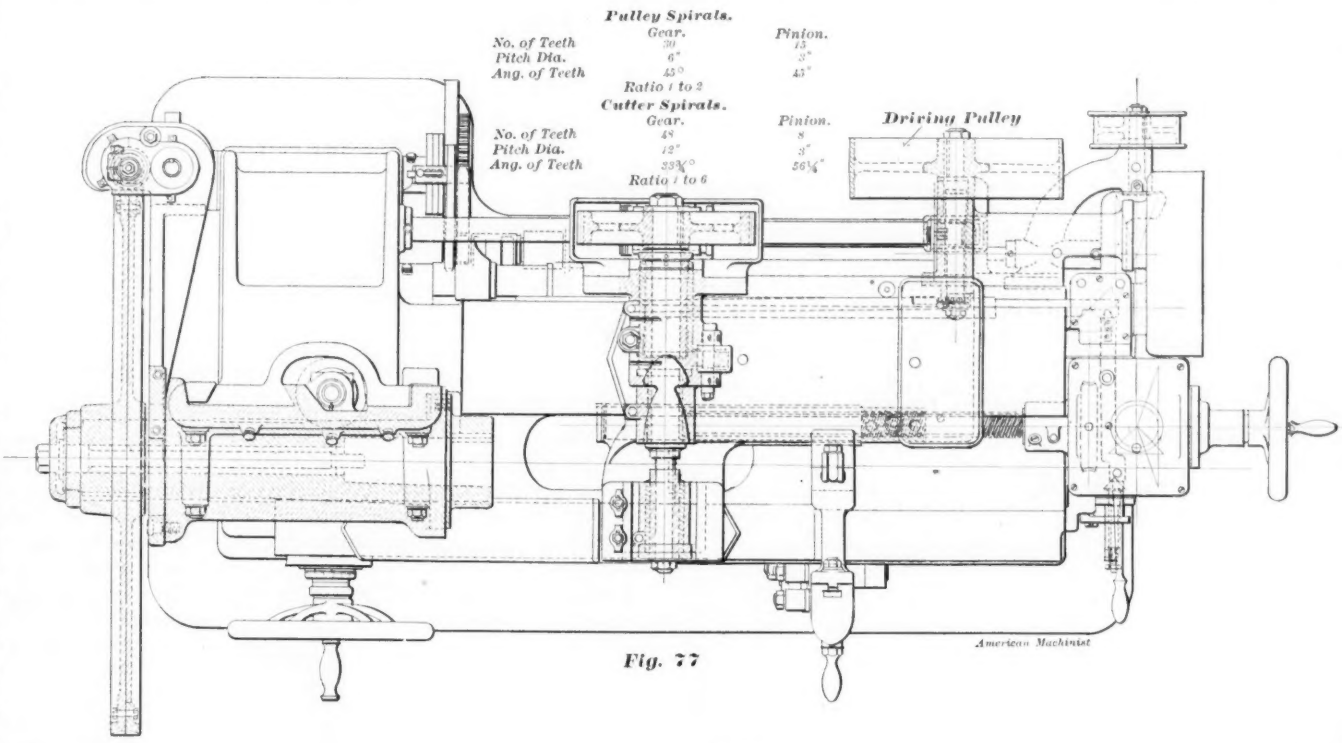


Fig. 77

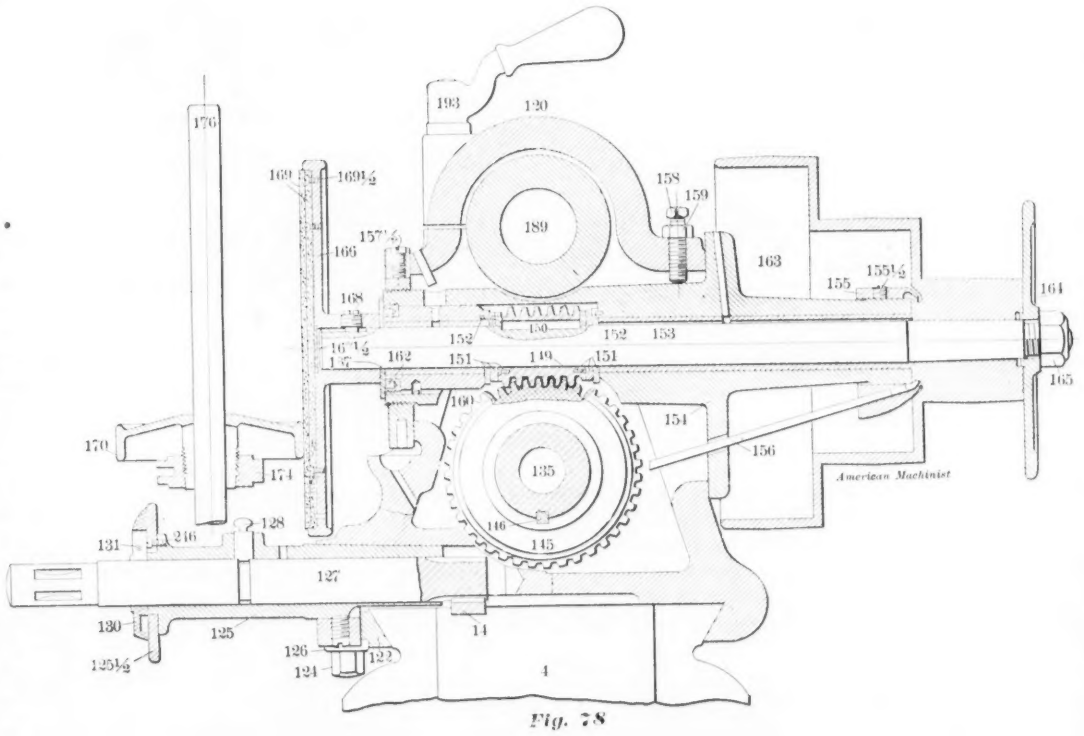


Fig. 78

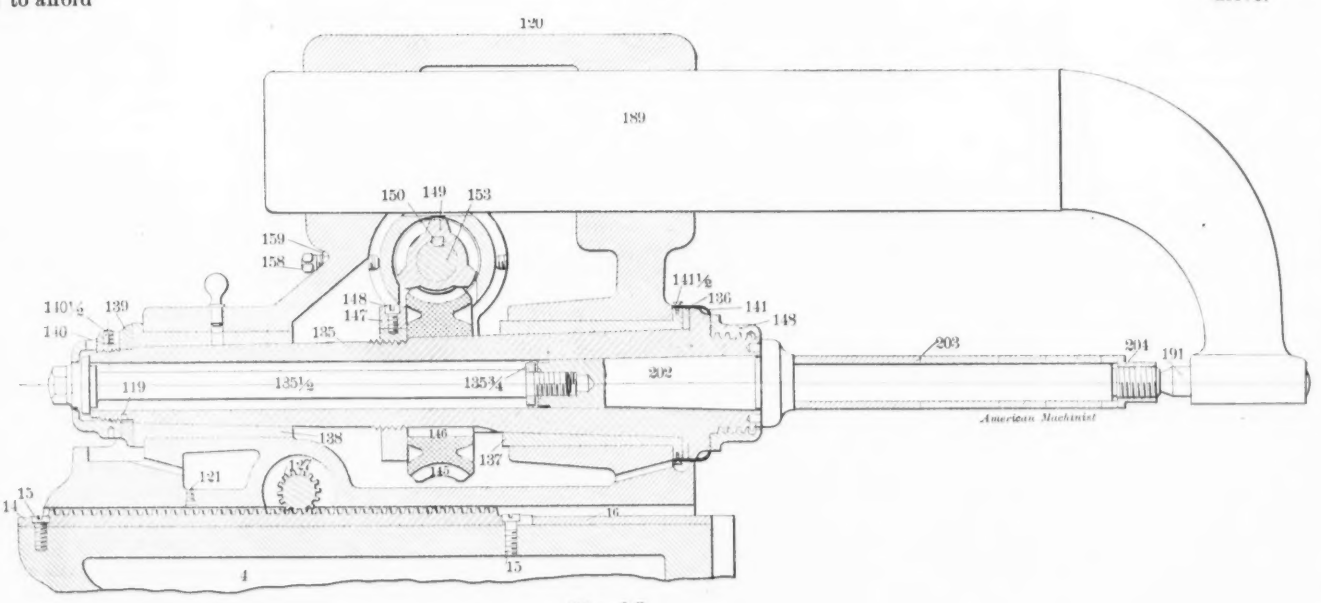


Fig. 79

MACHINE SHOP MILLING PRACTICE.

This machine also offers a new variety of cutter spindle drive, in that it is neither a spur gear or worm gear, but a spiral drive with quick angles in both the driving and driven members. As shown in plan, Fig. 78, the cutter drive consists of a driving pulley on an axis parallel to that of the cutter spindle which carries a 15 tooth 45-degree angle spiral pinion driving a 30-tooth 45-degree angle gear on a shaft at right angles to the cutter spindle, which carries a spiral pinion of 8 teeth 56¼-degree angle, driving a 48-tooth 33¾-degree angle gear of 48 teeth on the cutter spindle. Perhaps the extreme smoothness of operation secured by this unprecedented combination of a double set of quick angled teeth, is one important factor in the astonishing rapidity of cut in cast-iron which this machine can make.

I think it only just to here mention the broad spirit of generous bestowal of information which has always marked the policy of Brown & Sharpe management. It would be but natural for constructors in any line who had reached greatly superior results through patient experiment to retain the technical details of their construction for their own exclusive use as long as possible; and this double spiral cutter drive was not successfully installed at the first attempt; both that, and the No. 24 spiral drive, which I here show in detail in Figs. 78 and 79, were the subjects of extended experiment, and involved some very discouraging events, before satisfactory angles and tooth shapes were developed. My request for details of these two mechanisms was received with some surprise, it is true; but after a consultation the blue prints were furnished, with an added card of the angles, as given in Fig. 77.

There is no question in my own mind in regard to the superior fitness of a spiral drive as compared with a spur gear drive for milling machine cutter spindles, and I do not think the cutting edges of mill teeth have nearly the endurance with the spur gear drive that they show with a spiral drive.

In regard to the No. 24 cutter spindle drive, I can only say that I do not see how it is possible that such a small worm gear spindle driver should turn such a gang of mills as is shown in Fig. 60 (page 5, June 28th issue), for an instant. That this drive does carry such cuts constantly and easily I know to be true because I have seen it.

I have only to add that tool designers in general will undoubtedly examine these reproductions of Brown & Sharpe drawings with careful interest. The drawings themselves are so clear that those who care to read them will have no difficulty in fully comprehending the details and subtleties of construction therein exhibited.

The Brown & Sharpe "patent relieved" gear tooth mills are so widely known that

I need not mention them except to avoid a charge of inadvertence on my own part. The same result, a tooth which can be ground on the face without altering the profile of the cut produced, can be had in cutters of widely differing forms, some samples of which are shown in Fig. 76, and almost any form of cutter desired can be made with this patent relief. The vast advantage of being able to sharpen cutters without in any way altering the cut produced by them is readily apparent.

Fourteen-inch Hendey-Norton Lathe.

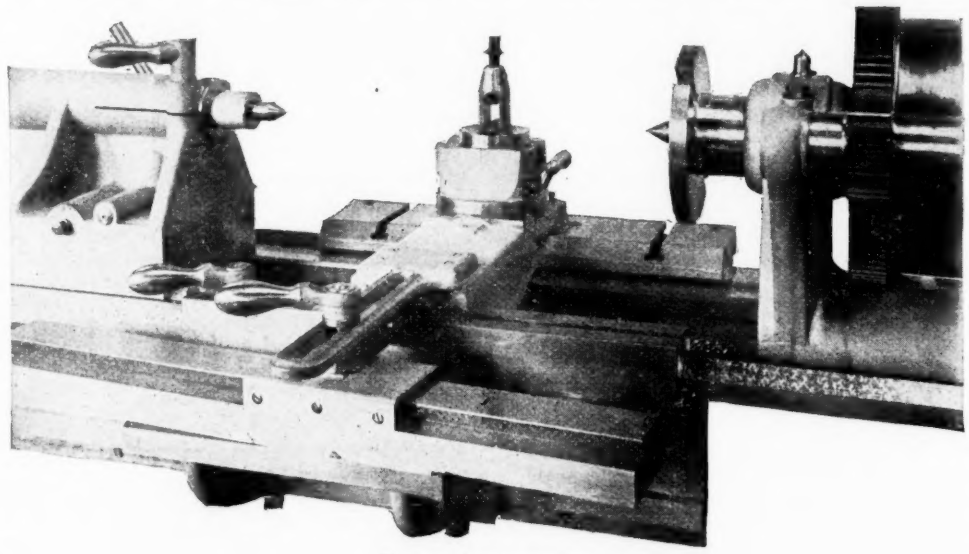
We give with this an illustration of a small size Hendey-Norton lathe, mounted in a pan in accordance with the practice first introduced in screw machine practice, but now being quite frequently employed for lathes. It is, of course, much neater and every way better than to have a box on the floor, especially where much oil is used in cutting operations.

This lathe is intended especially for tool and other light, fine work, and when desired is fitted with draw chucks for the spindle, the same as are used on watch lathes.

The other special features of the lathe are, of course, familiar to our readers, as they have been described in former issues. It will be noticed that it has, in addition to the permanently attached change gears, the new automatic carriage reverse stop, which operates in either direction.

We give also a reproduction of a photograph of the taper attachment as now put onto these lathes. The attachment is carried on a bracket on the back of the lathe, and can be set and used anywhere in the length of the bed lathe. The handle and link are to bind the cross slide to the taper attachment, and thus overcome the trouble arising from the slack or lost motion in the screw and nut. The attachment is graduated to set either to degrees or parts of an inch.

The lathes are made by the Hendey Machine Co., Torrington, Conn.



TAPER ATTACHMENT.

"Back-woods" Hydraulic Engineering.

BY JAMES F. HOBART.

A small factory water-works, consisting of wind-mill pump, reservoir and distributing system, gave excellent satisfaction for several months after being put into operation, and plenty of water could be had at all times until a breakdown of the wind-mill allowed the reservoir to become empty. Repairs were at once made, and water again supplied to the reservoir, but to the surprise of those dependent upon the system, no water could be obtained from the taps ordinarily used, but a full and continuous stream of water could be obtained from a tap located in the cellar of the shop.

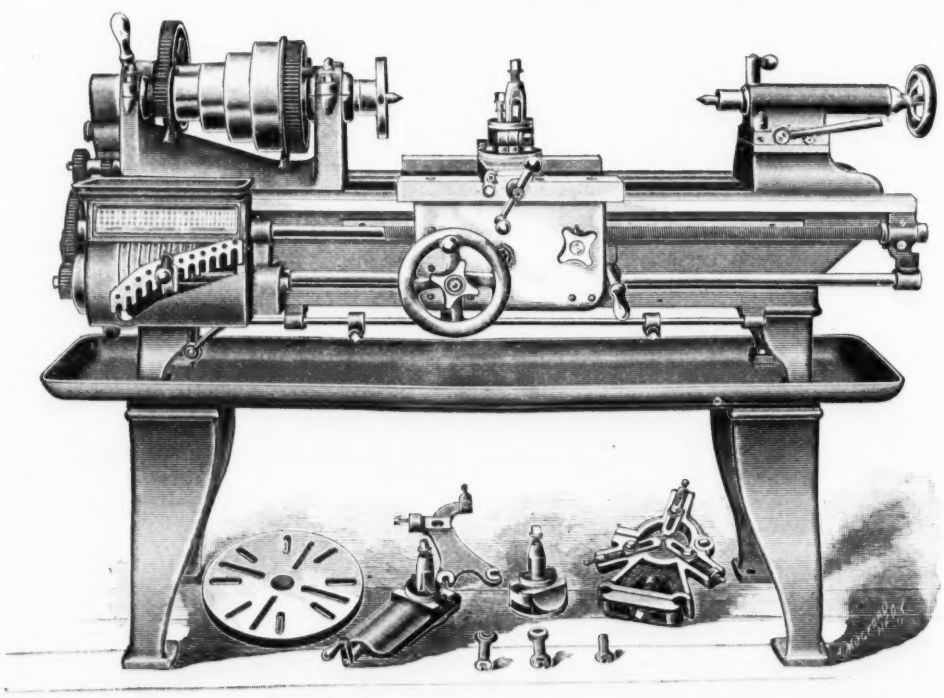
The service taps were located about eight feet above the cellar taps, but by putting on a water line glass, attached to a cellar tap by a rubber tube, it was proved that the water rose only about five or six feet, when, according to the height of water in reservoir, the water should have risen about eleven feet. Somewhere there was a loss of about six feet in head, between reservoir and service taps. After drawing water in the cellar, and carrying it upstairs for a period of six weeks, it was found that the water level was rising, and in eight weeks the water had risen to its old level, and flowed freely from the regular service taps *S*.

At this time the wind-mill failed again, the reservoir became temporarily empty, and after filling again, the same old trouble commenced anew. But the eight weeks water carrying was discounted this time by attaching a force pump to a cellar tap, and forcing a barrel of water *backwards* through the pipe. And it cured the trouble proving that somewhere in the pipe air became bound upon refilling the reservoir each time.

It was determined to ascertain the cause of the trouble with this water system, but as it was back in the country, away from all engineering instruments, except a carpenter's wooden level, just how to survey the pipe line and acquire data enough to plot its profile from, was quite a question. It was known that the pipe was buried to a uniform depth of three feet, and that was the extent of the available data, except size and length of the buried pipes.

The making of a passably accurate plan and elevation of the pipe line having been determined upon, the securing of a level, and a transit, or their substitute, became the question of the hour. An instrument like that shown in Fig. 1 was constructed by the expenditure of five hours, and less than fifty cents for material, the carpenter's level, before mentioned, being made the "active principle" of the concern.

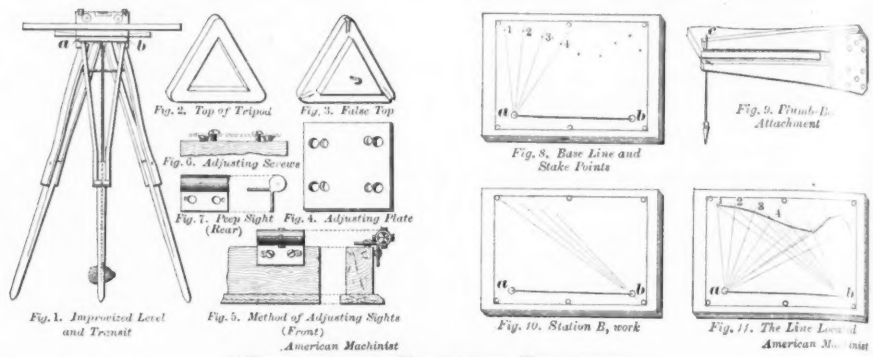
The tripod of the writer's photographic camera was next pressed into service. This tripod was made for a large camera, and originally had a triangular head, 10 inches on a side, but upon making a new head, the old solid form was dispensed with, and a head made like Fig. 2, also 10 inches on a side, but a frame, instead of a solid board.



FOURTEEN-INCH HENDEY-NORTON LATHE.

A piece of board (pine) was sawed out the same size as the tripod head, and another bit of board nailed on, which would just fit snugly inside the frame. Fig. 3 shows the "false top," and it also shows three grooves cut in the underside of the false top. Into these grooves wedges were snugly fitted. The wedges are shown in position just above the letters *a* and *b*, in Fig. 1. These wedges are for leveling the tripod head.

The top and false top of tripod are shown at *a* and *b* respectively in Fig. 2, but the wedges are not shown. The screw hook seen in Fig. 3 can also be found in Fig. 1, but there is a cord attached to the hook, and a heavy stone hung thereto, the object being to keep the false top and the tripod firmly in position, for upon the stability of this part of the apparatus depends the accuracy of the work performed by the instrument.


a
b
Fig. 1. Improvised Level and Transit
Fig. 2. Top of Tripod
Fig. 3. False Top
Fig. 6. Adjusting Screws
Fig. 7. Peep Sight (Rear)
Fig. 4. Adjusting Plate
Fig. 5. Method of Adjusting Sights (Front)
American Machinist
Fig. 8. Base Line and Stake Points
Fig. 9. Plumb-Bob Attachment
Fig. 10. Station B, work
Fig. 11. The Line Level
American Machinist

"BACK-WOODS" HYDRAULIC ENGINEERING.

A piece of emery cloth (sand paper will do) was glued on top of the false top (Fig. 3), and a large drawing board laid thereon. With the carpenter's level placed on top of the drawing board, the instrument was complete, and served to make a successful diagnosis of the diseased water supply system. Lighting was done along one side, and on top of the level, but refraction, caused by the pouring of air currents over the edge of the level, caused so many possible sources of error, or inaccuracy, that it was determined to fit up a level with sights, and keep it for special use as a part of the instrument. To this end sights were rigged, as shown by Figs. 5, 6 and 7. A plain bit of brass, or two pieces, were drilled and slotted, as shown by Fig. 4, then bent horizontally in the middle, to a right angle, and a short bit of brass tube soldered on, as shown by the end elevation of Figs. 5 and 7. For the forward sight, "cross-hairs" were put into the tube, and knotted through holes drilled in the four small screws shown, which in reality are not screws at all, but smooth round bits of brass shaped like screws. The holes through which the cross-hairs are passed were drilled close to the edge of each screw, eccentric, in fact, so that by turning the screw blanks the "hairs" may be adjusted to the center of the tube.

The rear sight is of the "peep" variety (see Fig. 7). This sight is made exactly like the front sight, instead of having "cross-hairs" a bit of metal is soldered over the end of the tube, and a minute hole drilled as near the axis of the tube as possible. A "straight edge," shown at bottom of Fig. 5, was fastened (glued) to the level, and the business edge of this straight edge must come exactly perpendicular to the cross-hairs in the forward sight. If not quite in line, the adjusting screws soon brought things right.

Fig. 6 shows the working of the adjustment screws, the flat head screws bear on the *under* side of the adjusting plate, and these screws are reached by putting a screw driver through the larger holes in the adjusting plate. The flat screw head bears "all around" the screw-driver hole, while the half-round screws serve to clamp the sights in place when adjusted to suit. In using this instrument in windy weather, I prefer to make the drawing board stay in place during use by putting a couple of weights on top of it, moving either weight as it got in the way of the carpenter's level.

To use this instrument upon the "pipe line," a series of stakes were driven along on top of the pipe. All the stakes were placed a certain distance from each other, and in this case, the stakes were driven every two rods, as shown by the dots in Fig. 8. It is desired to locate these dots upon a sheet of paper, in such a manner that their distances and angles will have been correctly ascertained and recorded.

Two stakes were driven a certain measured distance apart, and this distance, say, 100, 200 or 500 feet, served as a "base-line" upon which all subsequent operations were based. A similar base line, laid out to any convenient scale, was drawn upon paper, a sheet of which had been fastened upon the drawing board in the regulation way.

The instrument, Fig. 1, was then "set up" at station *a*, and the corresponding point (*a*) on the paper on drawing board brought perpendicularly over the stake or hub driven into the ground. To accurately bring a certain point on the paper, to the required position, is a hard job to do without the device shown by Fig. 9. This consists of the needle point *c* piped vertically in line with the plumb line. A very elaborate tool may be made up for this plumb-bob attachment, but it will answer equally well, if made up, as in Fig. 9, of bits of half-inch pine boards, glued and nailed together as shown.

In use, the point *c* is placed upon the mark on drawing paper, *a*, and the board moved until the plumb bob falls directly over the point taken on hub or stake. After

thus locating point *a*, Fig. 8, the sighting level was placed on the board, touching point *a*, and directed to a staff held vertically upon point *b* at the other end of base line. In all sighting operations, the beveled side of level straight-edge, Fig. 5, is used to work from, the other side *must not* be used.

Having drawn the base line *a b*, Fig. 8, the point *b* is directly located by laying off from *a* the length of the base line, or any convenient length may be assumed, and scaled afterwards. The sand or emery paper between drawing board and false top (*b*, Fig. 1), prevents the drawing board from shifting, but it is well to lay on the two weights mentioned, now that the instrument has been adjusted to the base line. Keep the "level edge" on point *a*, and successively sight the stakes on line of pipe, and draw lines 1, 2, 3, 4, etc., until all the stakes have been sighted. Occasional testing by sighting the base line, will prevent error from moving of the board.

Having located all the stakes from station *a*, remove the instrument to *b*, locate point *b*, Fig. 10, over the corresponding point on base line, place level edge on line *a b*, and verify work by noting that the sights cover the staff when held on end of base line at *a*, proceed to sight all the stakes again, drawing the lines shown in Fig. 10, superimposing these lines over those in Fig. 8, producing the network of lines seen in Fig. 11. Connect the intersections of the two sets of lines, as shown by the heavy line, and the latter represents the outline indicated by the range of stakes. Placing these an equal distance apart, serves as a constant check upon the drawing, for if the points 1, 2, 3, 4, etc., do not measure equidistant, some error exists which must be corrected at once.

Leveling of the stakes was done at the same time the lines were drawn, the distance on rod cut by horizontal cross-hair being taken off, and entered against the corresponding stake number. A few of the stakes around the summit of the reservoir hill were too high to come within the sights of the instrument, these stations were taken from a new setting of the instrument at two of the stakes already sighted.

If a field, or some other figure than a simple line is to be plotted, a plan of it may be made directly in the field, by setting the instrument at each angle, and after adjusting the last forward line to a back sight, a new line may be sighted and drawn by passing a pencil along the "level edge." Only a chain to measure the distances, and a scale for taking them off against the "level edge," is necessary, and the field is surveyed and plotted all at once.

By the use of this simple instrument, built in a few hours' time, the pipe line was surveyed, leveled and plotted, as shown in plan by Fig. 12, and in elevation by Fig. 13. The plan view is of little value, except to show the general location of the pipes, the stop valve, the angles, etc., sizes of pipe, which are 1¼ and ¾ inch, respectively, and also to show a curiosity in the construction of house cellars. The two circles in oblong at right of drawing, represent two cellars in the house served with water. These cellars have walls built up with a single course of brick, laid "4 inch wise" for thickness of wall. The outside earth thus presses upon the outside of a true circle or cylinder, and helps to make an apparently frail 4-inch wall into a "retaining wall," strong enough to hold many times the pressure ever put upon it. In construction, the pipe was *driven* from one cellar to the other, with little trouble, the cellars are about 12 feet in diameter.

Returning to the water supply question, Fig. 13 shows that there is a high place at *F*, higher than the opening of pipe into the reservoir. At *C* there exists a low place, 1½ feet below the highest point, *B*, between *C* and outlet *A*. When the reservoir is empty, it is evident that the pipe between *D* and *B* will be full of water, also the pipe will be full from reservoir to *F*. From *D* to *F*, then, the main pipe 1½ inches in diameter will be filled with air, which has no chance to escape in either direction, causing it to stay in the pipe, and make it "air bound," so to speak.

Water drizzles over the high place at *F*, and compresses the air in the pipe, gradually filling it with water to the line *E*, 5 feet 3 inches above cellar tap, and just level with the floor line; the water refused to rise higher than this point, because the pressure of the air compressed in the pipe between *D* and *F* was sufficient, acting upon the surface of water in the pipe above *F* to so lower the water level there that no more water could run over the high part at *F*.

As soon as the cellar tap was opened, the water at once issued full size of the opening, and continued to flow a full stream, because the drop in pressure caused by opening the pipe, removed the pressure on water level above *F*, and caused the water to flow. It seems, at first sight, as if the rush of water, when cellar tap was opened at *A*, would carry the air in the pipe along with the water and thus get rid of it. This might be the case (though somewhat doubtful) were the pipe at the lower end of the same diameter as at the upper end of the line.

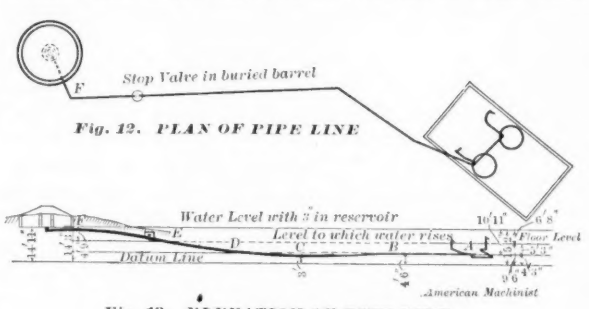


Fig. 12. PLAN OF PIPE LINE

Fig. 13. ELEVATION OF PIPE LINE

"BACK-WOODS" HYDRAULIC ENGINEERING.

As seen in the plan, the main pipe only extends part way, provision having been made to take out branches to other houses to be erected in the future, therefore, the ¾-inch pipe could not reduce the compressed air pressure sufficient to allow a rush of water which would clear the pipe, hence the steady flow maintained at *A*, through full opening of the small pipe, by the "drizzling" over of water at *F*.

The failure of water to rise to level with water in reservoir was then due to "loss of head." The pipe from *E* to *F* being filled with air, and occupying a vertical distance of 4 feet 9 inches, robbed the service of just that amount of head, and being unable to raise the water in cellar end of pipe higher than the floor line, the usual service pipes were unable to deliver it. Hence the water-carrying and profanity on the part of the tenant during the period of eight weeks, required by the water supply to regain its usual head and level.

The cause of this "resumption of head" was due to the absorption of air in the pipe by the water passing through it. A comparatively small stream of water trickling down through the air confined in the pipe, had every opportunity to absorb to its full capacity, which it did, permitting the pipe to be gradually filled with water.

The use of a force pump at *A* cured the trouble by filling the pipe with water by driving the air over the high place at *F*, and out into the reservoir; the *air seal* at that point, while impervious to the slight pressure of air in pipe due to head of water above *F*, could not resist a force of several pounds per square inch applied by the force pump at *A*.

A cure for the trouble is to vent the pipe at *F*; a pipe attached at this point and open to the atmosphere above the level of the water in the reservoir, will permit all the air to escape, but allow none of the water to get out. Prevention would have been better, and was very easy and simple in the beginning. All that is necessary would have been to lower the pipe at *F* by digging the trench deep enough so there is a gradual descent of the pipe from the bottom of the reservoir, with no place in the pipe for air to become trapped. That remedy can be applied now by digging up the pipe from *E* to the reservoir and lowering it to a regular grade. Tapping in an air vent at *F* is, however, the cheapest way out of the difficulty.

Technical Terms—Driving Ropes.

BY W. H. BOOTH.

THE AMERICAN MACHINIST of December 21, 1893, contained an article by Mr. W. H. Harrison giving an account of his visit to a French naval vessel. I had a good laugh over this, the French translation of a donkey pump, "*pompe de petit cheval*," or "pump of the little horse," especially striking me as irresistably funny, and the same of the donkey boiler, "*chaudiere de petit cheval*"—boiler of the little horse.

The origin of the use of the word donkey was, of course, a jest, having reference to the term horse-power; the small pump engine being of less than one horse-power got called a donkey power, and the name stuck. I don't know how it appears to the foreigner, but the translation into French is extremely comical and seems to argue a paucity of language in things mechanical.

Curiously enough, large numbers of mechanical terms all over Europe are English. The Portuguese have recently been worrying themselves to find a word to replace the English term tramway. Whatever be the faults of English nomenclature, a short and direct word is usually forthcoming; the nearest resemblance to the French paragraph which does duty for "locomotive," namely, "*machine de vapeur de chemin de fer*," being the American expression for a "horse tramway," viz., "horse street railroad," which same is the only instance which occurs to me of Americans lapsing into the sin. The Germans are as bad as the French in their mechanical terms; at least so it has seemed to me lately when helping a translator of German technical publications. True, the Germans call a center punch "korner," or something similar, which is commendable brevity, but as a rule the names are as awkward as the manifolded metre rule. Then a boiler becomes a "dampf-kettel," and so on, all which reminds me of a Lancashire workman of my father's who had been in Belgium and wound up his record of experiences, which had not impressed him favorably, with, "besides, the fools, they call a hammer 'marteau.'" This was too much to be patiently endured. I believe it is still the case that the French have no standard of screw threads. Every firm has its own. I remember in my young days that for temporary use in the erecting shop we had a lot of large bolts removed from old work which we had been called on to replace. These old bolts had every manner of thread on them, relics of a pre-Whitworthian age.

It occurs to me that the difference between the English and American screw thread is an unfortunate fact. One of them ought to be changed.

I have lately been helping a friend with some new rope gearing, and though familiar with this type of gearing my experience has chiefly been with examples having a rim velocity of 4,000 to 5,000 feet per minute. In my friend's case the conditions are such that the velocity is limited to 2,000 feet, and yet for this apparently small speed the power per rope when worked at usual tension allowance is fully three-fifths that of maximum velocity, which is about 5.000 feet, beyond which the power very rapidly falls away by reason of the rapid increase of the centrifugal tension. There is practically no gain of power above 4,000 feet velocity. Though a high speed gives a good fly-wheel action it has come to be looked upon as a necessity for the ropes themselves, until at last people whose conditions are really well fitted for this mode of gearing decline even to consider it because they cannot see their way to securing the necessary rim diameter to give the speed which they have been led to think essential. While, therefore, for economy in first cost of ropes I would not design for less than 4,000 feet rope speed, if the conditions allowed of this, I would not refuse speeds of quite low velocity. With high speeds we can use fewer ropes and narrower rims, but if the low speed does call for a wider rim we must not forget that the pulley diameters are less, and they will both cost and weigh less, for the diameter decreases faster than the breadth increases. It is, indeed, open to doubt whether high rope speeds are not absolutely a mistake in many cases. They have at least not that absolute value which should give them a right to reject the system of rope-driving at low speeds.

In a table before me, calculated on certain assumptions as to total allowable tension and slack side tension, the velocity of maximum effort is 4,700 feet, and the power differs less than 1 per cent. from that at 4,400 and at 5,000 feet. Now, of these two velocities of equal effect the ropes are bent somewhere about 12 per cent. fewer times round the smaller pulleys at the lower speed than about the high speed pulleys, and it is the bending of ropes which destroys them.

In my own tables, also calculated on assumed data, I find the maximum effort at 77 feet per minute, starting on an assumption that the strength of a 1¾-inch diameter rope of cotton weighs .98 pound per foot and may be worked at 600 pounds tension. From this 600 pounds I take 10 per cent. for slack side tension, and from the remainder I subtract the centrifugal stress.

The residue is the working tension, and at 77 feet per second the product of this and the velocity is a maximum and gives 50½ horse-power per rope, which is less than some tables give which are based on a higher total rope stress. One table allows 720 pounds per 1¾ rope, but takes away 20 per cent. for slack side tension, and this gives a net-working tension a little higher than my allowance.

In this matter, however, there may be, as in the speeds, a wide margin of variation.

Under favorable conditions the cost of ropes may come out as little as one cent per foot per year, while two cents per foot would begin to indicate something wrong. This applies to ropes of cotton; other materials of a fibrous nature being not now used in England for driving ropes, unless leather may be called a fibrous material. The so frequent employment of manila for driving ropes in America seems to me a curious use of a foreign material when a better native grown article is at hand. Manila hemp is too rough in fiber for use as a drive rope, for it works itself into dust internally. Here all our ropes are of American or Egyptian cotton, leather or wire; comparatively few of hemp of any description being now used.

LETTERS FROM PRACTICAL MEN.

Train Motion and Resistance.

Editor American Machinist:

Referring to the criticism of my recent article on the above subject, by C. W. MacCord, Jr., in the October 11th issue of this paper, I would say that I have considered the tractive force of the locomotive to be the *maximum pull that it could exert without slipping.*

I have made no statement or assumption regarding the velocity or mean effective pressure, my calculations being based on the forces acting at the rail. Using the above definition of the tractive power (which Mr. MacCord is pleased to call the *adhesive power*), one sees at once that it bears a definite ratio to the weight on the drivers, the values of which ratio under different conditions I have given in a table, and whatever power the locomotive might develop as a stationary engine, and which is correctly given by the formula quoted from Haswell and Meyer, the greatest tractive power which the locomotive can exert on a train is that above defined.

It should be the aim of a locomotive designer to so proportion the cylinders and weight on the drivers that the locomotive may be capable of exerting this power.

Assuming that the locomotive is so proportioned, then the maximum velocity which the train can attain is given by formula (3) of my article.

The ordinate of the velocity curve as the train moves from rest constantly approaches, but never reaches this maximum, so that a line drawn parallel to the axis of X, at a distance equal to the maximum velocity on the given scale, is an asymptote to the velocity curve, as shown in my drawings.

Albion, Mich. R. E. HORTON.

Fly-wheel Accidents.

Editor American Machinist:

Mr. Wakeman's remarks on this subject in your issue for December 21st, '93, serve to direct attention to a species of disaster which unhappily threatens to become only too common unless engine builders and power users join hands to prevent it. The fact is worthy of note that of the many recent failures, by far the largest proportion appear to be of band wheels. In England large spur driving wheels occasionally fail, but it is not often that the main fly drums used for rope driving fail, although scores of them are running to-day at rim speeds exceeding 5,000 feet per minute.

That either the metal or the workmanship, in the case of the American wheels, are inferior to those of British construction cannot, I think, be advanced to account for these facts, and we must therefore look elsewhere for an explanation.

This, I believe, will be found in the heavier rims usual in rope-driving wheels, and the greater rim stiffness due to the peculiar disposition of the metal therein. With comparatively light band wheels it is not difficult to see that the portions of the rim between the arms will bend outwards under centrifugal action much more easily than would the similarly placed segments of a rope wheel rim. Then, again, the metal used for fly-wheels is not, as a rule, of any too good a quality, and the presence of honey-combing and blow holes not infrequently reduces the rim section to a very dangerous extent; but it is pretty clear that while the strength of the thin rim of a band wheel may in this way be seriously jeopardized—a defect of similar extent in the rim of a rope wheel will not affect it in any very great degree. It may, of course, be held that defects of this kind may be in proportion to the rim section, but while this may be true of band rims it will be seen that owing to the corrugations in the rope rims the metal is disposed in a manner calculated to reduce the risk of large blow holes to a very material extent.

These considerations appear to me to point conclusively to the desirability of increasing the depth of the bent beam of which each rim segment may be said to consist. By the addition of internal flanges to the rims of large high-speeded wheel rims and the bestowal of a little more common sense upon the jointing of the rim and its connection with the arms—engine builders might unquestionably reduce the risk of failures of this description very materially.

But, so far as the power user is concerned, I am afraid we have not much to hope for. The usual limit of circumferential speed—80 feet per second—corresponds to a stress of 668 pounds per square inch of rim section, and if the ultimate strength of the metal is taken at the low figure of 14,000 pounds per square inch, we have a safety factor of over 20, which certainly appears sufficient to allow of a little "speeding up," now in such general request. Having regard, however, to the risks and difficulties peculiar to such constructions, to the indeterminable stresses set up due to cooling and to the treacherous nature of cast-iron generally—the prudent man will keep within the old-established speed limit and thus reserve a margin for contingencies which in the event of his engine racing may be sufficient to save his wheel from destruction.

The appended table may be of service to those who are desirous of ascertaining at a glance how these wheels stand with regard to the speed limit above referred to:

Diam. of wheel in feet.	No. of revs. per minute = 80 ft. per sec., rim speed.	Diam. of wheel in feet	No. of revs. per minute = 80 ft. per sec., rim speed.
6	255	21	73
7	218	22	69
8	191	23	66
9	170	24	63
10	153	25	61
11	139	26	59
12	127	27	57
13	117	28	55
14	109	29	53
15	102	30	51
16	96	31	49
17	90	32	48
18	85	33	46
19	80	34	45
20	76	35	44

M. E.

The Engineer in a Modern Naval Battle.

Editor American Machinist:

I send you the following clipping from the *Army and Navy Journal* of October 13th, which is a magnificent and up to-date illustration of what may be required in war time from the engineers of naval ships. The only thing which I can see to cast any doubt upon the truthfulness of the story is the name of his ship which he gives as the "Yang Wai," which may be a reporter's blunder.

In London *Engineer*, October 5th, the "Yang Wai" is stated to be a small vessel, which was destroyed while the "Ching Yuen" made her escape "badly hulled." The description given with a picture shows a ship with heavy guns forward and aft, with twin screws and a nominal speed of 18 knots, which tallies well with the narrative; but the description is for the "Ching Yuen;" the London *Engineer*, however, says in one place that "there may be some confusion in the names," which, I might remark, is only natural among the disciples of Confucius. The article in the *Army and Navy Journal* is as follows:

Following is a graphic description of the great Japanese naval battle, given by a young Englishman who was supervising engineer on the Chinese cruiser "Yang-Wai," and who has come to the United States for treatment for injuries he received in the battle:

The Chinese Admiral received word from Pekin, July 12th, to watch the Japanese without making any aggressive move. The "Yang-Wai" was accordingly detailed to proceed to sea and keep an eye on the Japanese.

She overtook the Japanese fleet eighty miles to the southward, passing through their lines in defiance of the Japanese Admiral's orders to stay away, and making a spurt, led the Admiral's flagship a swift race. When the rest of the fleet had been left out of sight in the distance, the "Yang-Wai" suddenly turned and planted a 10½ inch shell out of a 38-ton forward gun in the port bow of the "Metsuchima." It tore an enormous hole in her upper deck and disabled three of her 8-inch guns. Passing the "Metsuchima" on the return tack her secondary battery was fired broadside into the Japanese vessel, and as she passed astern her 25 ton gun came to bear on the Japanese vessel's after barbette. Several of the Japanese guns were disabled before she was able to return the fire.

Some clever maneuvering followed and both vessels proceeded to pour broadside after broadside into each other. The battle lasted from 11.30 o'clock in the morning until 3 in the afternoon. After the "Yang-Wai" had been disabled, with the exception of the big gun forward, she managed to cripple her opponent by a shot which struck the conning tower of the Japanese vessel, killing the Japanese Admiral and several of his officers. This completely disabled the Japanese ship.

Shortly after the "Metsuchima" ceased firing, and while we were busy ascertaining the extent of our own injuries, we sighted the other Japanese vessels approaching and the "Yang-Wai's" commander gave orders to make a run for it to Weipalwei.

The scene aboard the "Yang Wai" after she had withdrawn from the unequal conflict was simply hideous. There was but one gun left in fighting trim, and that being the big bow gun, it was useless in flight. The six Japanese warships pounded away at us as we ran, and we were devoutly thankful that our speed was great enough to soon get out of range. The "Yang-Wai" was simply a floating wreck. Above the water-line everything was ruin. The pilot-house, bridge, and conning tower had gone early in the fight; the boats were shot into splinters, and the superstructure was in a hopeless, shapeless tangle. The funnel had been shot away to within four feet of the deck, and, as we were running under forced draught, we rigged a jury stack of sheet iron and canvas supported by a derrick. A hose was kept playing constantly on this makeshift funnel, to prevent it from taking fire or melting.

The captain directed his crippled craft from a jury bridge of empty liquor casks and soap boxes, using a boat's compass, as the binnacles had been shot away. The masts were gone, and the rudder, too, but steering with the twin screws was comparatively easy. The "Yang-Wai" had been in commission nine years, but we got twenty knots out of her, or two knots better than she did on her trial trip.

The junior officer was sent down to take charge of the stokeholes, where naked coolies were shoveling coal for dear life. He had several cases of gin, which he gave to the sweating stokers as often as they asked for it. In one hand he held a thick club made of a section of thick rubber belting, and whenever a man lagged he beat him with it until he picked up his shovel again. The draught that was produced was so fierce, that a continuous sheet of flame poured from the jury funnel. Below, the cruiser was a huge butcher shop. Holes fourteen feet square yawned in her side, marking the place where the Japanese shells had entered. These war engines in bursting had blown the upper deck into fragments. On the main deck was the worst of all. It was simply a lake of blood fully an inch deep in the shallowest part. Writhing in this and floating in the deeper parts were heads, arms, and legs, with here and there the fragment of a man still alive tangled among the fragments of timber and steel torn from the cruiser's sides and decks. There were only two white men aboard the cruiser, myself and the surgeon, a young Irishman named Kirk.

As soon as the vessel was out of danger from the shells of the Japanese gunboats, he and I, with a corps of the surgeon's assistants, set about clearing up the terrible mess on the main deck.

Wherever we found a man hopelessly wounded, the surgeon gave him instant relief from his agony. He carried an atomizer filled with prussic acid, and as soon as his hasty examination of a hopeless case was finished, he sprayed the poison into the man's mouth and nostrils. The dying men craned their necks forward eagerly in their desire to escape from the torture they suffered. There were very few of the wounded who were not put out of their misery by the surgeon's atomizer.

One of the most distressing features of an engagement like this is the terrific noise aboard a modern man-of-war fairly in action. The "Yang-Wai" fought all the time with one screw turning slowly, her fires raked clean, and the steam blowing off like the shrieking of a gale. The scream of the shells, the thud and the vibration as they struck the cruiser, the terrific roar as they burst, and the deafening noise and concussion of our own guns made it utterly impossible for anything else to be heard aboard the vessel. To my dying day I shall remember that July 12th, and, most of all, the horrible noise and the scene on the bloody main deck. We broke the record, I think, on our run to Shanghai, where we arrived at 4 o'clock on July 13th.

It seems to me that this young man and his mates, and even the poor devils of coolies, did a great and noble work on that day, in bringing home the miserable wreck by superior steaming. By the English account there were five of the Japanese vessels that were far superior in nominal speed, yet by the liberal use of gin and belting, and sharp attention to his bearings, he outran them all.

The jury (temporary) smoke pipe rigged up in that awful time is immense; it is in the old books as one of the resources in time of trouble, but I never heard before of its actual use.

In our war of 1812 the captain of the "Constitution"—I forget whether it was Hull or Bainbridge—acquired great praise for "kedging" his ship up Boston bay during a calm, keeping out of gunshot of a superior British force, but that was nothing at all, not a man had been hurt, nor a rope yarn parted.

We all hope that this young man's name will come out, and having escaped Dr. Kirk and his little atomizer, that he will "seek the protection that the British Consul grants," and finally return to old England in good condition, taking some of our Eastern cities on his way.

WILLIAM H. HARRISON.

Braintree, Mass.

English and American Patent Law.

Editor American Machinist:

That there is a difference between English and American patent law is well known, but it is understood in a general way that this difference is one of fees, and of duration, and, as a rule, no further inquiry is perhaps made by the American patentee on obtaining an English patent. I do not myself know much of the patent laws of either country, that I should take it upon myself to write much about them, but think that one item may be specially drawn attention to for the benefit of American patentees and that is in reference to the subject of claims. I am informed what amounts in brief to the following: that you may make any number of "claims" in an American patent, good or bad, and that all the bad claims may be simply ignored, and no harm is done to the validity of the patent. Now, in an English patent, if there is included among the "claims" any claim that cannot be maintained then the whole patent is invalidated. There must be nothing in the "claims" which cannot be substantiated as new, or the whole patent fails. Now, large numbers of American patents, when taken out in England, are simply the American patents transcribed. The whole of the wide claims of the American patent are included in the English patent, with the almost certain result that the patent is bad in England, and therefore valueless and disappointing. This is the fault of the agent who has the patent in hand, and American patentees ought to be careful to employ only agents who thoroughly know and appreciate this technical point, or they will be disappointed. There is a period during the taking of an English patent when a disclaimer may be put in amending the claim in respect of any item or items the sticking to which would invalidate the patent, and such disclaimers are frequently made. The rule may indeed be laid down that in America you may make your claim all embracing—in England it is safer to cut this down to the very narrowest limit, as it would be useless in a lawsuit to abandon any part of a claim once appearing in the final specification. Determine in fact what it is you have invented, claim this and stick to it, shearing off all excrescences as being so many knobs on which an opposing litigant could fasten to your discomfiture. Such at least is what I gather to be the kernel of the matter, and perhaps if not exactly correct in substance it is sufficiently correct to draw attention to a difference that exists, and should be at least understood by a patentee, so that the English specifications may be independently drafted from the American.

A disclaimer is a costly thing to set about and so every care should be taken to avoid the necessity for making this.

W. H. BOOTH.

Cylinder Proportions for Compound Engines.

Editor American Machinist:

In reading various of the elaborate papers on engineering subjects that are submitted from time to time at the meetings of the scientific societies, one cannot but remark the want of familiarity of their authors, with the restrictions governing practical design.

We are all familiar with the college prize set of "working drawings," and have learned to forgive their ambitious delineators, and the professors who inspected and made the awards; for the bolts located snugly in inaccessible pocketings, and other like trifling features of inconsistency, that are the markings of preoccupation, rather than of a vicious heart.

But when our theoretical friends, emboldened by experiments made on 4"x4" college engines, deliberately attack our triple expansion practice in the flank, and lay down a set of preposterous proportions that, they assert, will vastly decrease the consumption of fuel, it is time for some one to investigate, lest the God fearing pencil pushers of engineering establishments be led from the straight and narrow path, and in

consequence suffer decapitation on "steam trial day," at the hands of an infuriated corporation.

In your issue of September 6th is the reprint of a paper, in which cylinder ratios, cut offs, cushions, etc., are given for a triple engine, carrying 160 pounds absolute, and the cards are worked out, with all the latest refinements of limiting temperatures, drop, etc.

The author's leading thought, when engaged in the task of plotting the diagrams, is not given, and, therefore, it is impossible to say whether the receivers were considered as of infinite capacity, or whether the lately invented notion that each cylinder of a compound works like a simple engine between the same limits of pressure, held sway. The uniform back pressure in each cylinder calls for one of the two suppositions, and as neither will bear examination, the cards are simply makeshift contrivances, liable to mislead the inexperienced.

In the accompanying diagrams, which represent the H. P. and upper portion of I. P. cards of the cylinder ratios given in the article referred to, the engine is supposed tandem—for simplicity—and a receiver equal to the swept volume of H. P. cylinder is assumed.

The H. P. clearance is 5 per cent., and that of the I. P. is 4½ per cent.

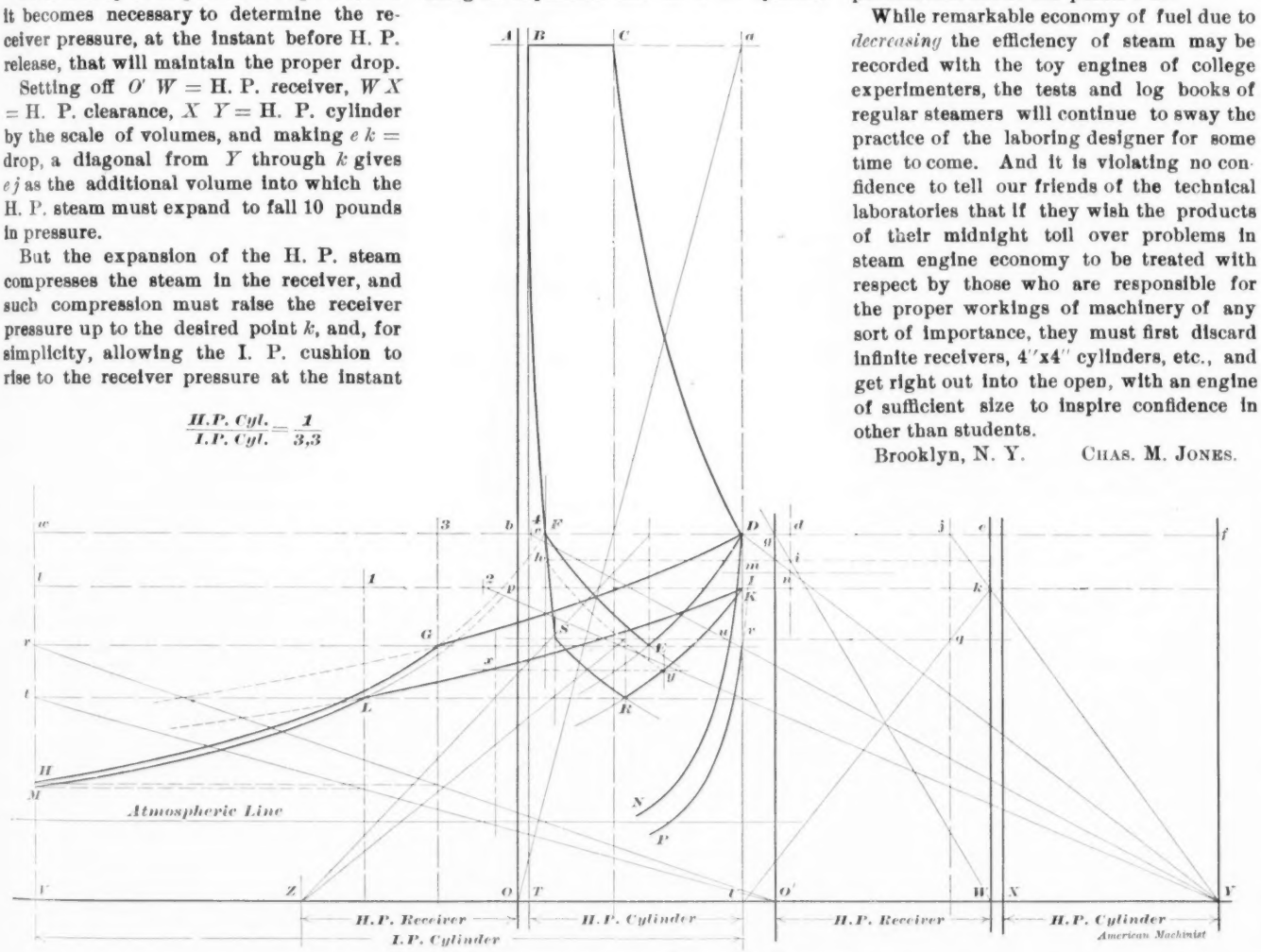
Steam is admitted at 160 pounds absolute, and cutting off at C at $\frac{4}{15}$ (as per scale of above referred to article) the pressure falls to D.

At D a drop of 10 pounds is required, and it becomes necessary to determine the receiver pressure, at the instant before H. P. release, that will maintain the proper drop.

Setting off $O'\ W$ = H. P. receiver, $W\ X$ = H. P. clearance, $X\ Y$ = H. P. cylinder by the scale of volumes, and making $e\ k$ = drop, a diagonal from Y through k gives $e\ j$ as the additional volume into which the H. P. steam must expand to fall 10 pounds in pressure.

But the expansion of the H. P. steam compresses the steam in the receiver, and such compression must raise the receiver pressure up to the desired point k, and, for simplicity, allowing the I. P. cushion to rise to the receiver pressure at the instant

$$\frac{H.P.\ Cyl.}{I.P.\ Cyl.} = \frac{1}{3{,}3}$$



CYLINDER PROPORTION FOR COMPOUND ENGINES.

before H. P. release, such I. P. cushion must also be compressed to the k point.

The I. P. clearance being $U\ O'$, the diagonal $U\ k$, cut by a vertical from j, gives q as the pressure in receiver and I. P. clearance, which will rise to K on communication being opened between the cylinders.

At the beginning of the back stroke the total volume in communication is $Y\ U$, and the pressure is $W\ k$, and from I setting off to the left on the pressure line $I\ l$ the spaces swept by the I. P. piston, and from the points so located setting *back* the spaces swept by the H. P. piston certain *volume points* are found, the positions of which from the initial line $U\ D$ measure the volume added to the initial volume $Y\ U$ by the motion of the pistons.

Diagonals drawn from Y to the *volume points* cut the initial line $U\ D$ at the *pressure points* corresponding to the points of volume, and the pressure points being transferred horizontally to both the H P. and I. P. piston positions, corresponding to the given volume points, the steam lines $I\ L$ and $I\ R$ are traced.

The receiver pressure must be at a certain point q when the H. P. cushions in order that the H. P. exhaust will drop to the given value, as has been shown, and drawing $q\ v\ S$ horizontal the intersection with the H P. cushion line fixes S as the cushion point.

Since the H. P. steam line $I\ R$ will not strike S directly, the I. P. must cut off at such a point, as will allow the H. P. piston to bank up the steam in the receiver to the proper pressure when the piston reaches S.

The point R must therefore be located, and setting off $O\ Z$ to the left ($O\ T$ being the H. P. clearance), an expansion line drawn from S, with Z as origin, $S\ n$ as initial pressure line, and a vertical through S as the line of initial volume, cuts $I\ R$ in R the desired point. [$I\ R$ and $I\ L$ are first drawn indefinitely, as shown by the thin and dotted lines respectively, and such points as R and L are located by intersections as required.]

The I. P. must cut off when the H P. piston is at R, and L is located by drawing a horizontal from R, or by making the volume $I\ 1$ swept by the I. P. piston, bear its proper ratio to the volume swept by H. P. piston when at the point R.

The H. P. card is $B\ C\ D\ I\ R\ S$, and the upper side of I. P. card is $I\ L\ M$; $L\ M$ being an expansion line in I. P. cylinder alone, using O' as origin, and $L\ t$ and $L\ 1$ as the lines of initial pressure and volume respectively.

In the original paper before referred to, great stress was laid upon the temperature limits, and the variation due to 10 pounds drop was advanced as about the proper amount.

With the herein given receiver volume, the actual total fall scales 31 pounds from D to R, or 21 pounds over that due to the drop alone.

Again, the actual proper cut off in the I. P. cylinder with the given receiver is at L, while the original article calls for the point x, which latter is an impossible condition, as is shown by the lines $x\ y$, $y\ h$, $h\ i$, and the diagonals $W\ z$ and $Y\ D$.

If, instead of dropping, the I. P. cylinder takes steam at the D point, and cushions full up, the cards will be $B\ C\ D\ E\ F$ and $D\ G\ H$, and the fall of pressure $D\ E$ will be—by scale—21 pounds, or 10 pounds less than in the first diagrams.

Without entering into any guesswork calculations in regard to the temperature losses in either case, it is safe to assert that the cards without drop will give the best results, there being the gain due not only to the toe of the H. P. card, but also to the fact that there is not the loss that is occasioned by releasing the H. P. steam at a pressure $U\ D$, into a receiver of, here, equal volume, filled with steam at the much less pressure $U\ v$.

This loss due to change of state in a mass of steam, when mixed with vapor differing considerably in pressure, is one of the main reasons why practical designers cushion full, and eliminate drop, unless restricted by some consideration other than *assumed* rates of cylinder condensation.

A rough approximation gives the size of receiver that will enable the I. P. to cut off at x (as called for in the original paper) as 16.7 times the volume of H. P. cylinder, where 10 pounds drop is allowed.

Pressure of other matters has prevented cards for the cylinders cross compounded from being drawn, but enough can be learned from those given to convince the uninitiated that points of cut off, etc., are not to be settled by any arbitrary ruling.

Considerable food for reflection will be found in the diagrams, such as the equality of areas $F\ E\ D$ and $F\ G\ D$, etc., and peculiarities about the points $I\ K$.

While remarkable economy of fuel due to *decreasing* the efficiency of steam may be recorded with the toy engines of college experimenters, the tests and log books of regular steamers will continue to sway the practice of the laboring designer for some time to come. And it is violating no confidence to tell our friends of the technical laboratories that if they wish the products of their midnight toil over problems in steam engine economy to be treated with respect by those who are responsible for the proper workings of machinery of any sort of importance, they must first discard infinite receivers, 4″x4″ cylinders, etc., and get right out into the open, with an engine of sufficient size to inspire confidence in other than students.

Brooklyn, N. Y. CHAS. M. JONES.

Some Points About Boring Mills.

Editor American Machinist:

I am now running a 12 foot mill of the latest make, and as one who is in actual contact with the machine in question every day, I will make a few suggestions which may be taken for what they are worth.

Where the work you have varies much it becomes tiresome as well as a loss of time to put on an exceedingly tight belt every time you have to raise or lower the bridge. Why would it not be practicable to put a clutch in the driving gear and make one belt do the work?

Another thing: All feed rods should be graduated. I marked mine myself, and it is quite a convenience, for I always know what cut I am carrying. The utility of this is so well-known that it is strange to me that it is not more extensively done.

I had some work not long ago, a description of which may not be amiss.

I had two drums 8 feet in diameter, 18 inches face, flanged on to the sides, to be used on a hoisting engine for a mine shaft. These drums were to be grooved spirally for 1½ rope. The grooving was to be done on the mill. The utmost I could get in the way of feed was five-eighths of an inch. Now my feed rods were such that one turn means one quarter inch. I laid off my drum in 20 parts with chalk marks, and every time one of these marks passed my tool I would give the feed rod one-quarter turn, not abruptly but with a gradual motion, feeding by hand. This gave me a screw of 1¼ pitch. It worked very satisfactorily but it was exceedingly hard work. J. W. Mc.

Vibrating Water Fall.

Editor American Machinist:

Regarding that vibrating sheet of water mentioned by Mr. Sangster in a recent issue, would say I have known of two such instances before. One of the dams was of the usual log construction, the other of solid masonry. The vibrations in each of these cases were felt a mile or more from dam, and loose doors and windows kept time. These dams were perfectly smooth and level on top, so the sheet of water was of uniform thickness throughout. I think these vibrations are almost sure to occur under such conditions. I cannot say what causes them, but they may be prevented by placing a few pins or pieces of driftwood on top of dam—anything to break the sheet.

York, Neb. E. N. EVANS.

That Wonderful Cupola.

Editor American Machinist:

We are in possession of your number of 27th September, and don't comprehend your surprise at the performance of our cupola, this performance being neither wonderful nor uncommon in our country.

It may be that our coke is different from yours, and if any ironfounder is desirous of ascertaining the sort of coke we use, he can see a sample of it at Messrs. Rogers, Brown & Co., Carrew Building, Cincinnati.

The air pressure is 35 centimeters.

Brussels, Belgium. H. BOLLINCKX.

Professor Van Dervoort, of the department of Mechanical Engineering, University of Illinois, writes us that the University starts out well this year in his department, with a gratifying increase of attendance. A new engineering building is nearing completion, which will cost $160,000, and to the equipment have been added during the past year a 30 inch by 30 inch Gray planer, No. 2 Brown & Sharpe universal grinding machine, No. 3 Brown & Sharpe plane milling machine, 27 inch by 12-foot F. E Reed Co. engine lathe, 20 inch Barnes combination drill press, Lodge & Davis sensitive drill press, besides emery grinders and other minor tools.

We have received from the H W. Johns Mfg. Co., 87 Maiden lane, New York, a pamphlet entitled, "Heating, Insulation and Fire Protection in Prominent Buildings." The pamphlet, though it gives illustrations only of the buildings in which the H. W. Johns asbestos covering is used, yet includes a large share of the most prominent buildings in the leading cities of the country, and as it is beautifully illustrated and printed, it forms a very attractive publication, and will be found of interest to all who are interested in either steam plants or in architecture. It is sent free to any address upon application.

Mr. C. H. Norton, who has been one of the firm of the Leland, Faulconer & Norton Co., Detroit, Mich., has severed his connection with that firm, and will hereafter devote his attention to a consulting business in mechanical engineering and to expert work in connection with patent causes at 12 Hodges Block. He will devote particular attention to special machinery and tools. His extended experience as a designer of such machinery well fits him to succeed in this line.

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☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

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NEW YORK, NOVEMBER 1, 1894.

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The Machinist in the Foundry.

An engineer who devotes his attention mainly to and is especially interested in machines for use in foundries was remarking the other day that he knew of a case where an establishment making large numbers of steam-pipe elbows had built a special machine at a cost of about $4,000 for tapping these elbows, the saving effected by the machine as compared with their older methods being only a few cents on the hundred elbows; yet it was all they expected, and was enough to warrant the expense of the machine.

The manager of the same establishment was shown, conclusively, that by the adoption of a certain molding machine for making these same elbows the cost of their production could be reduced, as compared with his present methods, considerably more than 50 per cent. The machine was not ordered, and our friend looks upon this as a typical illustration of the peculiar difficulties which lie in the path of the man who attempts to do missionary work in the foundry. Here was a concern willing to make close figures on the possible saving by the use of a machine to be set up and used in their machine shop, and to be guided by the results shown by the figures even though the margin was very small; yet when the same concern came to consider a machine of much greater economic potentiality for their foundry, figures showing a very large margin, failed to impress them sufficiently to influence their decision in favor of the machine.

This and many other similar instances are probably due mainly to the fact that successful manufacturers have been educated up to the point of taking every possible advantage, and introducing every possible improvement in machine-shop and kindred operations, while in the foundry they have so long been accustomed to letting things go in the old way that the mere introduction and use of an improved machine or method that, were it in the machine shop, would be taken as a matter of course, is here looked upon as revolutionary, and, in fact, so much of a departure from the beaten path as to make it seem like a leap in the dark.

No doubt the fact that improved machines which are to be used in machine shops will be under the care of, if not operated by machinists, skilled in such matters and interested in their success, while in the foundry it is usually different, undoubtedly has much to do with the matter, and in many instances this feature of the case is of considerable importance.

Nevertheless, nothing seems more certain than that foundry work is to be greatly improved within the next few years, and in no way more than by the increased use of machinery for doing that large proportion of work which is scarcely more than a repetition of the same cycles of movements and operations from morning until night, and from Monday until Saturday—work which any intelligent man can quickly learn to do, and which no molder, worthy of the name, ought willingly to work at.

It is almost needless to point out that the manufacturer whose foundry work is adapted to it and who admits the machinist and his methods into the foundry first, and before it becomes the universal practice, will reap the largest rewards of his enterprise, and if he wants to be fully abreast of the procession he will be very cautious about concluding for himself what is and what is not suitable work to be done upon machines. Rapid advances are being made along this line, and unless a foundryman has fully investigated the matter, and is sure about it, he had better look into it. There are some difficulties in the way, perhaps, but so there are in the way of about everything that is at all worth doing, and what is work, after all, but simply a continual overcoming of difficulties of one sort or another. The machinist has invaded the foundry and will remain there, not to do the work which requires the skilled and highly-trained molder—work which requires the exercise of the real art of the molder—but to do all that large class of work which is small enough and made in sufficiently large numbers to make it worth while to put in and operate machines

Newcomen's Engine.

The picture we published last week—a reproduction of a photograph of an engine made by Newcomen, will naturally be found quite interesting to all who are in the least interested in mechanics, and especially in the steam engine, and it is interesting to think, as we look at this picture, what it represents in steam engine development, built as it was by a man who, though he was the first to build practical working steam engines, and undoubtedly deserves much more credit for his work in their development than he commonly receives, yet knew nothing of using steam on both sides of the piston, used the cylinder as the condenser, injecting water directly into it, operated the valves by hand, and applied the engines to pumping only (knowing nothing of changing the reciprocating motion to rotary motion except by the indirect method of pumping water into the buckets of an overshot wheel), used no governor, knew nothing of working steam expansively, and used steam at so low a pressure as often to be below that of the atmosphere, so that, it is said, his boilers were frequently operated with the manhole plates off.

It was an engine of Newcomen's make, and probably one very much like the one shown in the engraving, that the boy Humphrey Potter, who, in 1713, was employed to run it, compelled to do its own valve-opening and shutting by the simple expedient of attaching strings to the walking beam.

Watt's inventions, though of the utmost importance, and founded upon what was probably the first scientific study of the properties of steam and its use in engines, were yet based entirely upon Newcomen's practical working engine, which had been used for many years in pumping water from mines; and, while it is true that Newcomen's engine could never have come into very extended use, chiefly on account of its wasteful working, it is also true that Watt might never have done anything at all with engines if it had been necessary for him to begin where Newcomen did, instead of where Newcomen, who died about 1813, left off.

Though James Watt may properly be called the father of the *modern* steam engine, and of the science of steam engineering, Newcomen was, in a broader sense, the father of the steam engine; for he it was who first made it a practical working machine, and it is to be hoped that a way will be found to preserve this example of his work, which, though it may seem to us so crude, was yet the creation of a genius of a high order, and represents achievements the value of which can never be even approximately guessed at.

As our readers know, it is not our custom to refer to advertisements in our columns, but we make an exception to one appearing on page 15 of this issue in which our infant contemporary, *Machinery*, puts up its little fists at us and says we have "damned it with faint praise." If it will open its little eyes real wide, it will see that there was no praise, either faint or strong, in what we said of it; the chief reason for this absence of the usual complimentary welcome being that all its contents appeared bodily and entire in the *Journal of Railway Appliances* about the same time; the contents of one journal constituting the entire contents of the other, and we hardly knew "which was which," or where our praise should be bestowed. Our young friend intimates that we are real mean because we did not refer to its cheap price (50 cents a year, or 5 cents a number) and to the fact that it has a nice new overcoat *printed in three colors;* but, bless its little heart, it must learn not to put much stress upon its clothes, because, it is so easy for other papers to get overcoats with *four* colors, if they want them, and as to cheapness, which is the quality our friend puts special stress upon, and particularly plumes itself upon, why, the real interesting comparison to make is between this journal at 6 cents a copy and *Machinery* at 5 cents, only we did not like to say so right out in meetin', because, as Mrs Partington said, "comparisons are odorous."

Literary Notes

A DICTIONARY OF ELECTRICAL WORDS, TERMS AND PHRASES. By Edwin J. Houston, A. M., Ph. D., Emeritus Professor of Natural Philosophy and Physical Geography in the Central High School of Philadelphia; Professor of Physics in the Franklin Institute of Pennsylvania; Electrician of the International Electrical Exhibition, etc. Third edition. With appendix.

This dictionary of electrical science is the latest and best that has appeared, and will justly be ranked among the standard works. The scholarly nature of the work, its conciseness and completeness, give sufficient evidence that it was carried out by one well qualified for the task. This edition contains an addition of about 20 per cent. of matter to the previous issue, including the new electrical words and terms which have been introduced during the last two years, and also the work of the World's Fair International Electrical Congress, and of the Committee on Units and Standards of the American Institute of Electrical Engineers, bringing the work down to the year 1894.

Its 667 double-column octavo pages contain upward of 6,000 distinct words, terms or phrases, and 582 illustrations. The scheme of the treatment is as follows: First, the words, terms and phrases, which are set in bold-face type, are invariably followed by a short, concise definition, giving the sense in which they are correctly employed; second, a general statement of the principles of electrical science follows, on which the definition is founded; third, when, from the complexity of the apparatus or from other considerations, it has been thought desirable to do so, an illustration or diagram of the apparatus is given; fourth, to facilitate study, an elaborate system of cross-references has been adopted, so that it is easy to find the definitions, as the words and synonyms are readily detected and traced.

It will be noticed that the second item of the plan makes the dictionary approach to some extent the nature of an encyclopedia. It differs, however, from an encyclopedia in its scope, as well as in the fact that its definitions in all cases are concise.

The expert and those engaged in the electrical industries will find this work to be a valuable and exceedingly useful one, and the fact that so many of the definitions are new, and are not to be found elsewhere in any form, renders the work almost indispensable to students of general electricity and electrical engineering. The clearness, elaborate and popular treatment of terms, etc., will be appreciated by those who have had no training at all in electricity, or who are novices in the art, and by all who are in any way interested in this science. It is published by the W. J. Johnston Company, 253 Broadway, New York. Price, $5.

The *Inventive Age*, of Washington, is at present making a special feature of the exposure of the fraudulent methods of certain patent agents and patent brokers. It is a useful work and ought to do good, but, after all, is it not possible to boil the matter all down into the simple, common sense business rule never to pay money to strangers without having in hand a return for it, or making a rigid and thorough examination of standing, reliability, etc?

The latest candidate for public favor in the form of a technical journal is called "Modern Progress." It is published at Erie, Pa., by the Modern Progress Co., and no announcement is made as to the personnel, either of the company or of its editorial corps. It devotes its attention mainly to machinery matters, chiefly local.

Chief Engineer Melville, in his recently published report, says that the U. S. Navy now possesses several vessels that have no equals in fighting and maneuvering power, speed and endurance.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(500) X. Y., ——, Pa., asks: What is considered to be the average cost per horse power per hour of producing steam from coal in Philadelphia or New York? *A.*—See answer to Question 374 in our issue of August 9th, current volume.

(501) B. W. S., Detroit, asks: Will you kindly inform me whether or not it would be safe to pass a tube heated to 100° F. through a tank of gasoline, providing it was submerged; would it assist to vaporize the gasoline? *A.*—So far as we are aware it would be safe to pass such a tube through a tank of gasoline, and then heat it to the temperature named, and it would undoubtedly cause a more rapid vaporization of the oil. All such operations with such a volatile oil must, of course, be conducted carefully and absolutely controlled so far as possible. 2. I have a number of cylinders to bore of cast-iron four inches in diameter. What form of reamer will give the best results for these? *A.*—Much will depend upon the character of the machine in which the reaming is to be done, but ordinarily the usual form of reamer would be entirely satisfactory, only it would be best usually to make the body of the reamer either of soft steel or cast-iron and insert the blades in suitably formed grooves. It will be better also if the spacing of these grooves is made somewhat irregular.

(502) J. V., Hartford, Conn., writes: Please give me an easy and reliable formula for computing the indicated horse-power of a proposed simple, compound, and triple expansion engine. *A.*—See answer to Question 496 in our issue of October 25th, current volume. 2. Please give me an easy way for finding approximately the mean effective pressures in the different cylinders. *A.*—In case of any multiple stage engine, where the power is divided equally amongst the cylinders, the mean effective pressures are found by the following formulæ:

$$P_l = \frac{p}{N}$$

$$P_i = \frac{p}{N} \times \frac{\text{L. P. area}}{\text{I. P. area}}$$

$$P_h = \frac{p}{N} \times \frac{\text{L. P area}}{\text{H. P. area}}$$

In which p = equivalent mean effective pressure, that is the pressure that would be required if the work of all the cylinders were to be done in the low-pressure cylinder; N = number of cylinders, P_l = mean effective pressure in the low-pressure cylinder, P_i = mean effective pressure in the intermediate cylinder, P_h = mean effective pressure in the high-pressure cylinder, and L. P., I. P., H. P., denote respectively the low-pressure, intermediate, and high-pressure cylinders.

(503) R. W. R., Brooklyn, N. Y., writes: We have a beam engine with a cylinder 28 inches diameter, and 6 feet stroke, working with a steam pressure of 50 pounds per square inch, cutting off at 4 5 feet of the stroke, and running at the rate of 25 revolutions per minute. It is now proposed to use a surface condenser having 750 square feet cooling surface; the temperature of the circulating water is 70 degrees. It is also proposed to use a combined air and circulating pump, the diameter of the steam cylinder is 14 inches; that of the water cylinder 14 inches, and that of the air cylinder 16 inches; all have a stroke of 18 inches. Is the amount of cooling surface large enough, and are the pumps large enough? *A.*—The indicated horse-power of this engine (condensing) is 320; for such a high terminal pressure as in this engine we prefer three square feet of cooling surface per indicated horse-power; hence the total heating surface should be $320 \times 3 = 960$ square feet, but with pumps of the size given, which are too large for the purpose, a sufficient quantity of cooling water can be circulated for maintaining the required temperature in the condenser with a cooling surface of 750 square feet. To do so will, of course, necessitate an extra expenditure of power. The capacity of a double-acting circulating pump, and also that of the air pump, is found by the following formula:

$$\text{Capacity in cubic inches} = \frac{\text{Indicated horse-power}}{\text{Revolutions per minute}} \times 150.$$

(504) W. H., Erie, Pa., writes: I wish to make a surface plate about 12 by 24 inches, and would like to know the best form of plate, and the method of producing a true surface. *A.*—One of the difficulties to contend with is the tendency of the plate to deflect. In order to provide against this deflection, the plate is made to rest upon three bearing points which are cast to the ribs, these prevent the plate from rocking, even when it stands on an uneven surface, and whatever sag or deflection the plate may have will always be in the same direction, and may therefore be allowed for in the truing process. In some forms of plates there are two long ribs and a number of cross ribs cast to the back of the plate. The long ribs are placed as near as possible in the line of the strain between the three bearing points, and the cross ribs are placed at equal distances apart. The thickness of the ribs should be equal to that of the plate, so that changes in temperature will cause the plate to expand or contract equally. In other forms of plates, the ribs are placed lengthwise, crosswise, and diagonally, all of uniform and equal depth. To obtain an original true plate, it is necessary to make three. These are made as true as can be done by good planers and extreme care. The best plate of the three is selected and used as a test plate, to which the remaining two are fitted; the latter are then tested with each other, and any error existing between these two is proof of a want of truth of the first or test plate. The usual method of producing true plane surfaces is to finish it with a scraper; but it is claimed that filing and polishing is an improvement on scraping. For further particulars we have to refer you to Appleton's "Cyclopedia of Applied Mechanics."

(505) A. B., So. Meriden, Conn., writes: I would like to have a rule for computing the flow of water through a nozzle (not a ring nozzle). For instance, how many gallons of water will be discharged through a nozzle 1¼ inch diameter under 60 pounds pressure? I would like a rule that will apply to all diameters and pressures. *A.*—The discharge depends much on the form of nozzle. If the nozzle is cylindrical, and of a length at least equal to 2½ times the diameter, the discharge in cubic feet per second is found by the following formula:

$$.815 \times 8.02 \times A \times \sqrt{h}, \qquad (1)$$

in which h = the pressure head in feet at the nozzle, and A = the inner cross sectional area of the nozzle in square feet. When the pressure is given as in your example, multiply the pressure per square inch by 2 304, the result will be the head in feet. For conical diverging nozzles, whose lengths are about three times the smallest diameter, the following formula is used:

$$c \times 8.02 \times A \times \sqrt{h}, \qquad (2)$$

in which A = area in feet of the smaller opening, and c is a coefficient of discharge and depending on the angle of convergence, that is, the angle between the sides of the cone. The value of c may be taken from the following table:

Angle of convergence:	3° 10′	8°	10° 20′	13° 30′
c =	.895	930	.938	.946

Angle of convergence:	19° 30′	30°	40°
c =	.924	.895	.847

From these formulæ you can readily compute the discharge of the nozzle given in your example. Of course, the above formulæ apply only to the discharge into air, and not against any other pressure.

(506) S. A. B., Philadelphia, Pa., writes: Please state what power a 30-inch water wheel will develop; the water pressure is 150 pounds per square inch, jet ½ inch diameter. Also give the number of revolutions per minute of the wheel. *A.*—The horse-power and number of revolutions are found in the following manner: 1. To find the head due to the pressure. Multiply the given pressure per square inch by 2.304; hence

$$\text{head} = 150 \times 2.304 = 345.6 \text{ feet.}$$

2. To find the velocity in feet per second due to the head. Multiply the square root of the head by 8.02; hence

$$\text{velocity} = 8.02 \sqrt{345.6} = 8.02 \times 18.5 = 148.37 \text{ feet per second.}$$

3. To find the discharge in cubic feet per minute. Multiply the velocity as found above by the area of the jet in square inches by 12 inches and by 60 seconds; divide the product by 1,728. This gives us,

$$\text{Discharge} = \frac{148.37 \times .1963 \times 12 \times 60}{1{,}728} = \frac{148.37 \times .1963 \times 5}{12} = 12.14 \text{ cubic feet per}$$

minute. In a Pelton wheel the revolutions are based upon the peripheral velocity of the wheel being one-half of the spouting velocity of the water. Adopting this basis, we have, 4 To find the number of revolutions of the wheel per minute. Multiply the velocity in feet per second by 12 inches, by 60 seconds, and by .5; divide the product by the circumference of the wheel in inches. This gives us,

$$\text{Revolutions} = \frac{148.37 \times 12 \times 60 \times .5}{30 \times 3\ 1416} = 566\ 7 \text{ per minute.}$$

5. To find the theoretical horse power. Multiply the head by the discharge, and by the weight of water per cubic foot; divide the product by 33,000, hence, we have

$$\text{Theoretical H. P.} = \frac{345\ 6 \times 12.14 \times 62.5}{33\ 000} = 7\ 95.$$

When properly proportioned as to size of jet, etc., 85 per cent. of the theoretical horse-power is obtained, giving $7.95 \times .85 = 6\ 76$ horse-power. In this case, however, it seems to us that 85 per cent. must not be expected as the size of jet is very small compared with the diameter of the wheel. For a 30-inch wheel it would ordinarily be about 1½ inches, so that a ½ inch jet would have to overcome an undue amount of resistance. With a 12-inch wheel the same horse power would be obtained, while the revolutions would be 1,425 per minute. This wheel would be more suitable for the jet. For the above method of solution of the problem we are indebted to Mr. W. Cox.

(507) A. B., Alliance, O., writes: Please give the simplest method for obtaining the proper section of I-beams for the mast and jib of a crane, as per accompanying sketch. Kindly state it in the simplest form. *A.*—The dangerous section of the jib is at A, and the greatest stress in the I-beam occurs when the load is at B, in this particular case. We shall assume that the whole load is concentrated on the point B, in other words, we shall neglect the distance between the centers of the wheels of the carriage; this will simplify the problem. The jib is made up of two beams supporting 10 tons, hence each beam will support 5 tons. We now consider that we have to deal with one beam 8 feet long fixed at one end and supporting a load of 5 tons at the other end. The first step is to find the bending moment which is obtained by multiplying the length in inches by the load, hence we have $96 \times 5 = 480$ inch-tons for the bending moment. The strength of beams is computed by the formula

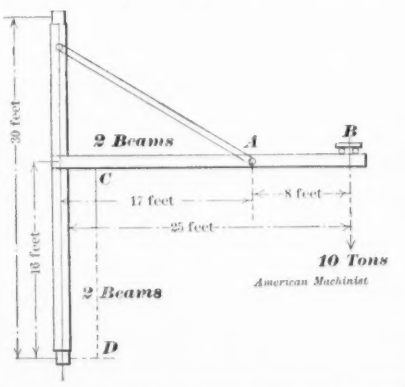
$$M = \frac{S \times I}{c}, \qquad (1)$$

in which M = the bending moment, as found above; S = stress per square inch on the fibers most remote from the neutral surface, for which we shall take a value of 12,000 pounds, or 6 tons; c = distance in inches from the neutral surface to the most remote fibers; for symmetrical sections the distance c is always equal to ½ depth of beam; I = moment of inertia about the neutral axis perpendicular to the web. From formula (1) we obtain

$$\frac{I}{c} = \frac{M}{S}. \qquad (2)$$

The value of M we have found to be 480, and for S we have taken 6 tons, hence

$$\frac{I}{c} = \frac{480}{6} = 80$$



In all pocket-books showing the sections of beams furnished by manufacturers of iron beams, etc. (which, of course, you must have in order to make a selection), you will find the value of $\frac{I}{c}$ given. Hence all there is to do is to look for the number 80 in one of these books, and if the exact number cannot be found, take the next higher number, and this will give you at once the dimensions of cross section of the suitable I-beam. The nearest higher number which we can find in a book before us is 83.4, which calls for an I-beam 15 inches deep with flanges 5.45 inches wide. To find the size of the I beams in the mast, we must find the force acting in a horizontal direction at the bottom of the mast. This is found as follows: Multiply the load by the length of the jib, and divide the product by the height of the mast, the result will be the force acting at the bottom in a horizontal direction. Hence we have

$$\frac{10 \times 25}{30} = 8.33 \text{ tons.}$$

The mast consists of two I-beams, hence each one will resist a horizontal force of $\frac{8.33}{2} = 4\ 16$ tons. We may now assume that we have to deal with a beam whose length is equal to $C\ D = 16$ feet, fixed at one end and loaded at the other. Reducing this length to inches, we have for the bending moment,

$$M = 4.16 \times 192 = 798\ 72 \text{ inch tons.}$$

Applying formula (2), we have

$$\frac{I}{c} = \frac{M}{S} = \frac{798\ 72}{6} = 133\ 12$$

The nearest number in manufacturers' tables is 144.9, which calls for an I-beam 20 inches deep with flanges 7 inches wide. This gives a beam a little larger than is required to resist the transverse force, but this excess will make allowance for the vertical pressure due to the weight of the crane and load which these beams have to resist. It should be remarked that since c and I are usually taken in inches, we must also take the length of the beam in inches when its bending moment is to be computed.

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Notes on Relative Tests for Cast-iron and Methods of Testing.

BY THOMAS D. WEST.

In reply to Mr. Cairns' criticism, published in September 20th issue, will say that I am pleased to learn he is interested in the establishment of a reliable system of tests for cast-iron, and I welcome any criticism that can in any way assist in the achievement of such an end.

EXPANSION OF CAST IRON.

The first point Mr. Cairns takes up is the question of expansion at the moment of solidification. Here he argues that the formation of Mr. Keep's gate would prevent such expansion.

One might as well argue that water could be so formed as to make it impossible to

expand when freezing. It makes no difference of what form or how a casting is gated, if the metal expands at the moment of solidification in a large body it will do so in a small one, the only difference being that in the small body its effect is to have its expansion act more quickly and in unison throughout the body of the test bar, and hence cause the greatest effect. The smaller a test bar the more pronounced the evil.

To prove to Mr. Cairns his error in asserting that a half-inch test bar will not expand, I would ask him to use a device as illustrated by Fig. 26, where the bar was, in experiments I made, gated just as Keep's half inch square test bars are. I also tried with this device half inch test bars without gates, pouring them in "open sand" or without a cope, and cannot say I found much difference in their expansion; if any difference the one with the gates showed the most. *H* is an iron block fitting tightly against the closed end of the flask. *B* is an iron block fitted loosely into the hole in the open end of the flask as shown. *D* is an arm of which there are two, one being attached to each side of the flask through which the pin *A* is inserted to give a fulcrum for the indicator arm *E* to revolve on as the half inch square bar expands.

The measurements given show the exact length of the two arms which I used to make the experiment. The dotted line of the indicator arm shows what the arm moves at the time of expansion, and which measured about one-half inch, sometimes going over this mark, and sometimes a little under it, thus disproving Mr. Cairns' logic based upon his hypothesis that a half-inch test bar is not able to expand when it has two branch gates which divide it into three bodies. Why he deems it necessary to cast test bars between rigid yokes so as to conform with general practice in the casting of molds, he has failed to explain.

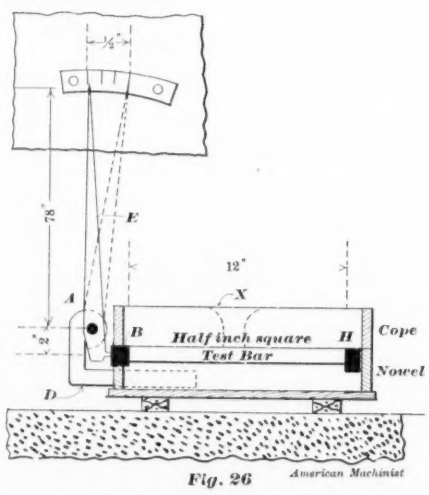

Fig. 26 American Machinist

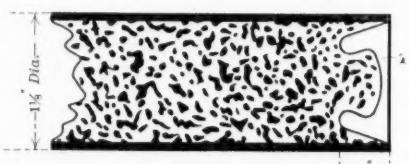

Fig. 27 American Machinist

OBTAINING KNOWLEDGE OF CHILL.

The next point we find Mr. Cairns condemning as useless, is my plan for obtaining the chill of an iron, and which calls for the test bar and its chill remaining in contact until both are cold to handle. He claims this is contrary to every-day practice, and says "that in the system of tests originated by Mr. Keep the chill is taken in the natural way, and is an exact indication of what the chill of the iron would be in chilled rolls, roller shells, cams, stamp shoes, crusher jaws and head shears, car wheels, etc. It will be evident therefore that for practical purposes Mr. West's ideas on chilling are not deserving of serious consideration."

To commence with, I will say that for such work as above described, and, in fact, any work that requires to be chilled, Keep's system cannot give an "exact indication" of chill, from the simple fact that a car wheel, chilled roll, or any of the above castings, which he says it is such a perfect test for giving the "exact indication" of the depth of a chill, would be white or chilled equal to the whole length of the half-inch test bar, and if it was a hundred feet long instead of one, it would be the same thing.

I did not assert that the size of a bar which I recommend for relative tests is a fit size to obtain the chill of such work as he claims Keep's test bar will give an "exact indication" of, and yet it is considerably larger in area than Keep's test bar. For such casting as he refers to, I advised a block to obtain a knowledge of the iron's chill, as spoken of in the article he criticised.

There are numerous elements which affect the depth of chill in a casting other than that of the chilling qualities of the iron used, and which make it impracticable to say just what the depth of a chill in a casting will be from the depth of chill in a test bar or block; my methods being no exception to this rule. All we can do with a test bar or block is to get a relative knowledge of the natural chilling qualities of an iron, and the depth the same may chill in a casting is dependent upon many other things than the iron used, and to illustrate this point I will now state some principles.

First—Any casting will show a deeper chill by remaining in contact with its chill until cold, than if the union of the casting and chill were broken before the former had cooled down to a black heat.

Second—Different degrees in fluidity of molten metal poured into test bars means that a hot-poured bar will remain longer in contact with Keep's system of chill than a dull-poured bar, for as soon as the molten metal has solidified it then commences to contract, and hence it must be plain that any one same grade of iron if pulled away quicker from a chill at one time than another will give a different thickness of chill, and hence be deceptive in giving any "exact indication" of the true natural chilling qualities of the iron.

Third—The least difference in the grade of an iron causes a variation in its contraction, thereby causing one quality of an iron to pull away from a chill more than another, and hence causing erratic thicknesses of chill to falsely indicate the natural qualities of the iron.

Fourth—The thickness of a "chill" used affects the depth of the chill in the casting.

Fifth—The thickness of a casting affects the depth of a chill.

Sixth—Degrees in fluidity affect chilling. A hot iron will chill deeper than a dull iron.

Above we have six factors which have to a more or less degree an influence in causing depth of chill in castings. Now let us analyze the practicability of a test bar giving an exact indication of what the chill will be in any of the above castings which Mr. Cairns has cited. Let us for illustration take a chill roll foundry. Any one that ever saw such a shop knows that all sizes are generally made in them, and the one ladle will often be used to pour at the same time a pit containing different diameters of rolls with their respective different thicknesses of chill. Mr. Cairns would say that a test bar would "indicate exactly" what will be the depth of the chill in all the different sizes of rolls. I have shown by the above that conditions have an effect in regulating the depth of a chill in castings, and that it is impossible for any one to tell what the exact chill will be in a casting by means of a chill test unless he has had considerable experience with the special casting and takes into consideration all conditions.

The only thing that the furnace, or the foundry for that matter, can give from a chill test is a knowledge of the relative natural chilling qualities of an iron, if some one correct chilling method has been used. This knowledge obtained, I then must, from experience with the work I would cast, draw my own deductions as to what depth of chill I might expect in the castings. To do this I must consider the thickness of my castings in connection with the thickness of the chill; also whether the casting is one to remain in contact with its chill or pull away from it; also the fluidity of the metal with which a casting is poured.

Mr. Cairns claims something for Keep's chill test that is not practical and which I do not claim for mine. I did not say my chill test would tell the depth a casting would chill, or even indicate what it would do. My article said "referring back to the question of chilling, it cannot but be readily seen that as arranged by this system the test bar and the chill must remain in close contact until removed by hand, hence truly recording the full chilling qualities of the iron." Take note it is the iron I talk about that is to be used in the castings, not the castings themselves. It is the natural qualities of an iron we require knowledge of, not the castings, for when they are completed it is beyond our control to change results. When we know the natural chilling qualities of an iron and the conditions to which it will be subjected in the mold, we are then in a position to arrange mixtures to obtain the results desired. It is the natural chill, natural strength and natural contraction we want knowledge of notwithstanding what Mr. Cairns says on these points to the contrary at the close of his article.

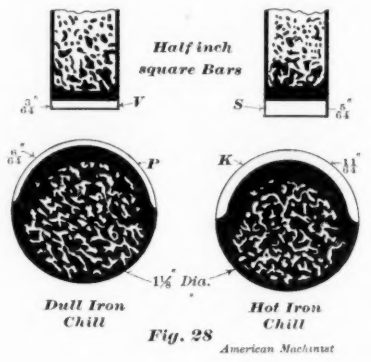

Fig. 28 American Machinist

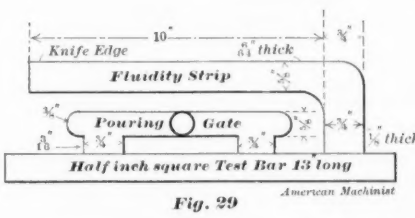

Fig. 29 American Machinist

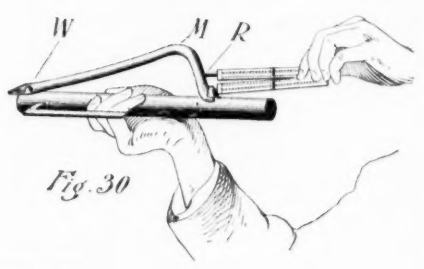

Fig. 30

TESTING CAST-IRON.

I wish, at this juncture, to call attention to a point which I have lately discovered as very important in considering the depth of an iron's chill taken by means of a test bar or block. It is a point which I claim annuls all past records or statistics which have been in any wise compiled from deductions taken from the depth of a chill, and I must say that this discovery has surprised me by the sensitive and pronounced manner in which it asserts itself in giving evidence of being affected by the degree of fluidity at which a test bar is poured. In experiments with iron poured "hot" and "dull" I can make the thickness of chill as much again in one case as in the other. Take, for instance, two test bars and pour one hot so that the iron will run up in the fluidity strips about six inches high and then cool the iron so as it will only run up about an inch, it will be found upon breaking the bars to test the chill that the hot poured bar will have chilled about as much again as the dull-poured one. I have not accepted this principle as a fact from a test or two but have made many to fully assure myself that the principle was correct. I would like to ask Mr. Cairns, with the evidence of this fact, if I am not justified in questioning the conclusions and records Mr. Keep has compiled chiefly from depth of chill in a half-inch test bar, especially so when he has neglected making any note or records of the fluidity of the metal with which he poured his test bars.

I will close this question with the following tables showing the difference in chill by reason of "hot" and "dull" poured iron. It will be noticed that the fluidity of the hottest poured bar in the first table was but 4 inches, and the dullest one 1 inch, a difference of 3 inches, but this was sufficient to make a difference in the chill of five sixty-fourths of an inch, and this was the same iron poured out of the same ladle. From a study of the chemical analysis of the following table it will be seen that the silicon was reduced and the sulphur increased in the heat, a point which I have called attention to in other papers, showing that in remelting iron we decrease silicon and increase sulphur. This point is well known to manufacturers of Bessemer steel. In Fig. 28 *K* shows the fracture of the hot-poured bar, and *P* the fracture of the dull-poured one from which a better realization can be received of the effects different degrees of fluidity can cause in giving different depths of chill from the same iron poured out of the same ladle and which is forcibly shown by the annexed tables.

In the table (page 11) we find a difference of .032 inch in the chill of the two ½ inch bars which were poured out of the same hand ladle holding about 15 pounds of metal. The first bar was poured as soon as the metal was carried to the "floor," and the second bar three minutes later. Here we find there is a difference in chill of .032 due to difference in fluidity of metal, or in rough figures $\frac{1}{32}$ inch, as seen at *V* and *S*, Fig. 28. I state the time between the pourings to give an idea of how long the metal was held. The fluidity strips are the practical guide to go by. Of what use is time in regulating or asserting the fluidity of irons between two foundries, or one heat from another? The iron in no two foundries is of the same fluidity, or for that matter the same foundry will seldom have two days' run in succession alike, and where one shop could only hold its metal for four minutes, another might do so for ten. There is no guide to register the fluidity of molten metal better than fluidity strips attached to test bars, as advocated by the writer. For scientific research and regulating mixtures by physical tests, it is essential for fluidity strips to be attached to test bars, where one desires to obtain true knowledge of irons or mixtures. I have shown that degrees in fluidity affect the depth of chill, also that it is incorrect for a test bar to pull away from its chill when contracting. This latter evil only the more aggravates the one caused by different degrees in fluidity, as both elements are effective in causing erratic depths of chill, so that Keep's system is in double error in its chilling arrangement, and when he ignores, as he does, the question of recording fluidity at the moment test bars are poured, I could not accept any tests he has recorded in his experiments as to the chemical and physical properties of iron. I could have shown a much more radical difference in the chill obtained from the same ladle by different degrees of fluidity, and would here say that in one case I found with the same iron in pouring two bars that the dull-poured one had a chill of $\frac{1}{16}$ inch, the hot-poured one $\frac{1}{4}$ inch, a difference of $\frac{3}{16}$ inch.

For any that desire to test the question of degrees of fluidity causing different thicknesses in chill, in ½ inch square test bars, I have presented the plan I used in my experimenting with a ½ inch square test bar, and which is as seen at Fig. 29. In using this device to get two test bars, I molded two separate patterns, as shown, in a flask large enough to admit the patterns, Fig. 29, having 4 inches of space between them, so that the gas from the first poured one could not affect the other bar. The flasks were leveled so as to afford like conditions for the running of the metal into the fluidity

strips. For chills at the ends of the test bars I used pieces of ½-inch square wrought-iron rods, cut to a length of 2 inches, and loosely set them against the ends of the pattern when molded. Should any one desire to cast two bars at the same time in one flask, they would simply require, of course, one gate, and it in the middle, leaving the fluidity strips on the outside of each bar.

FORM AND SIZE OF TEST BARS.

We next find Mr. Cairns presenting a theory on the form and size of test bar which I claim the best for obtaining the relative strength of cast-iron, and says it may possibly be good for roll or sash weights, but, as far as he knows, is not applicable to anything else. This looks like a desire to dispute for argument's sake. I am striving only to arrive at the truth. For the past four months I have been collecting a large series of test bars comprising ½ inch square, 1 inch square, and 1½ inches round bars in the rough and the same diameter in turned bars, from prominent makers of stove plate, light and heavy machinery, gear wheels, car wheels, chill rolls, gun metal and sash weight irons, and on the 24th of this month Mr. O. T. Stantial, Chairman of Testing Committee for the Western Foundrymen's Association, of which committee I am a member, will present a report of these tests, and I claim the same will prove the impracticability of using ½-inch square test bars as a relative test for cast iron.

TABLE I.

PHYSICAL TEST OF "HEAT" TAKEN OCTOBER 2, 1894.

MICROMETER MEASUREMENTS.

No. of Test.	Fluidity.	Shrinkage.	Contraction.	Deflection.	Strength, broke in Lbs.	Chill	Diameter of Test Bar.	Area of Test Bar. Sq. Ins.	Strength per Sq. In. in Lbs.
1	4″	30	.156″	.120″	1,505	.172″	1.130″	1.0028	1,501
2	1″	16	.156″	.110″	1,500	.094″	1.117″	.9799	1,531

COMMON MEASUREMENT.

1	4″	30	10/64″	7/64″	1,505	11/64″	1 5/64″		
2	1″	16	10/64″	8/64″	1,500	8/64″	1 7/64″		

Signature of Tester, THOS. D WEST.

ANALYSIS OF PIG-IRON CHARGED.		ANALYSIS OF TEST BARS.	
Silicon.	Sulphur.	Silicon.	Sulphur.
1.46	.039	1.26	.072

TABLE II.

PHYSICAL TEST OF TWO HALF-INCH SQUARE TEST BARS CAST OCTOBER 4, 1894.

No. of Test.	Fluidity.	Deflection.	Strength in Lbs.	Chill.
1	1½″	.190″	300	.048
2	8″	.190′	290	.080

Signature of Tester, THOS. D. WEST.

ANALYSIS OF PIG-IRON CHARGED.		ANALYSIS OF TEST BARS.	
Silicon.	Sulphur.	Silicon.	Sulphur.
1.82	.035	1.67	.056

CASTING TEST BARS AND CRYSTALLIZATION OF IRON.

Mr. Cairns says, "the fact that the round bar is cast on end condemns it," "as there would be a greater crystallization of the iron in its center than there would be in a square bar of equal cross section." I would say this is not borne out by my experience, nor by the points which I here bring forth as to specific gravity, breaking of test bars, and the general practice of casting rolls, guns, cylinders and all such work on end in order to get the best strength.

From Mr. Cairns' remarks we would infer that all castings, as they grow thicker than a piece of stove plate, could be cited as being cast on their side, and hence a test bar cast on end could not be a criterion to go by, and he says, "therefore we want the strength of the iron as we use it." By this logic the half-inch square test bar would only be of use for castings that might be one-half inch thick, and if we desired a test for a die block we would require the test bar to be the same thickness, let it be from one foot up to six feet high. All castings are not cast on their side, and as far as the crystallization which he writes about as occurring in castings cast on end, if it takes place at all, it does so to a greater or less degree in most every casting made, but I fail to perceive anything to affect results in his crystallization theory. The moment a casting commences to be thicker than a piece of tissue paper it is increasing its height, and as far as his crystallization theory goes, all castings can be said to be cast on end. Then, again, by his logic, the principle of casting any gun, cylinder or roll, etc., on end is wrong, for if we want to get the greatest strength in them his crystallization theory would assert they should be cast flat.

GAUGE TO REGULATE RAMMING.

We now come to the question of hardness in ramming. The principle which I advanced is one by which the degree of hardness can be systematized by measurement, and a little practice would soon cause a sameness in the diameter of the test bars, and hence, in a sense, give a gauge to guide the ramming, which in Keep's system is only to be told by the iron flying out of the gate towards the roof or by blow holes in the test bars when they are broken; hence often involving much loss of time and labor. You might say such results would soon teach the molder to ram the right degree of hardness. I admit this, but I prefer my plan, by which, in gaining the experience to ram properly, the workman does not produce useless test bars by reason of blow holes in a test bar which, when cast flat, are often found big enough to almost look through them. The uncertainty of obtaining perfect solid test bars when cast flat can be vouched for by any one that has had experience in testing. Mr. Cairns says his experience in testing square bars cast on end has been that the bar will break usually past the center towards the end cast up. I never experienced such an effect with round bars, and since reading Mr. Cairns' criticism I have experimented with round bars cast flat as well as on end to ascertain their difference, if any, in breaking at or away from the point on which the load is applied. I am inclined to think Mr. Cairns has drawn too strongly upon his imagination, for with about 20 bars cast flat and 20 bars cast on end within the last six days, I have failed to find any such results as he describes, and if there were any of the bars cast on end that did break other than at the point of load, it was more on the side of the load in the end of the bar cast down, or partly the reverse of what is ascribed by Mr. Cairns, and in reality I cannot say I found any difference beeween the bars cast flat and those cast on end in that respect. It may be, if Mr. Cairns will abolish the square bar, a form that cannot but have more internal strains within its body than a round bar, he will find the same results.

TURNED TEST BARS.

As Mr. Cairns seems to be ignorant of the fact that some engineers demand tests with turned bars, I will simply say I have designed my system so as to be applicable for such work, as well as tests with rough bars. There are engineers and men in the employ of our Government and in private positions that often exact and will not accept anything other than turned or planed test bars, and, again, some desire such bars to accompany a test of rough test bars. With my method all such requirements can be filled, and, so far as I can see, they cannot be with Mr. Keep's system.

MEASURING CONTRACTION.

We now come to the part in which Mr. Cairns condemns my method for measuring contraction. His objections being chiefly to its measuring in the three or four places of decimals. I designed this system so that those accustomed to close work in recording results could do so, but as Mr. Cairns shows a practical tendency in desiring common shop practice, it affords me pleasure to relieve his mind as to the necessity of his using three or four places of decimals. Most every one knows what a common six-inch rule is, and the cut, Fig. 30, will explain how one can readily and practically apply common rule measurement to my system if they so desire, and not only can the contraction be measured by the same means, but also the diameter of a test bar in the twinkling of an eye.

POURING CHILLED TEST BARS.

Mr. Cairns says, "any one acquainted with chilling an iron can see that the method of obtaining the chill by Mr. West is defective." Then, again, he says, "the iron passing through the chill at the bottom will wash out and prevent chilling at this point until the mold is full." If this was true or applicable to my method of chilling test bars, it would be impossible to make chill rolls, and I hardly believe Mr. Cairns would say that such work cannot be made. As a demonstration on this point, I will ask any one to pour some test bars wholly from the bottom, as shown by my plans in the AMERICAN MACHINIST of August 30, 1894, and then pour some wholly from the top by dropping the metal, as illustrated by my plans for casting single test bars or double ones from the top.

These two forms of gating and pouring are radical extremes. If the bottom pouring cuts the chill out, as Mr. Cairns says it will do, then the top pouring should afford an opportunity, or cause the test bar to be most all chill, but the facts in the case are that, instead of there being any such results, I can say from experiments which I have tried since reading Mr. Cairns' letter, that if any difference, with my first experiments the bottom poured bars would show a little the greatest chill, and which I accounted for by the fact that we poured the bottom gated test bar first, which, of course, means it would receive the hottest metal, and hence conform with the facts proven by this paper that hot metal will chill deeper than dull, and hence give us just reason in expecting a little more chill in the bottom poured bar than the top one, and with a few experiments which I tried by reversing the plan of pouring, or rather, casting, the top-poured bars first I cannot say that there was any difference when the fluidity of the metals are alike.

TESTING AND MEASURING SHRINKAGE.

Before answering Mr. Cairns on the question of shrinkage, I desire to compliment him, as far as my knowledge goes, on his being the second writer to correctly apply the terms "shrinkage" and "contraction," and if my plan for obtaining a record of shrinkage achieves no end other than to cause writers to apply these terms correctly, I will feel some good has been done on this point. I regret experience with my plan of recording shrinkage does not accord with Mr. Cairns' hypothesis on the subject, in which he says, "it will always show more shrinkage than is present in the iron." I also regret to say that I consider this feature a failure, in the sense of always showing that iron shrinks, for with soft iron one will often find an expansion instead of a shrinkage; then, again, a few moments after the bars are poured, what shrinkage may have taken place will often be partially filled up by reason of expansion, the metal oozing out, and often filling the first cavity, or forming a little ball, as shown by *T* in Fig. 27, and in soft grades of iron, unless poured very hot, the chances are that little shrinkage will be visible, but with iron that really possesses excessive shrinkage, if the test bars are poured fairly hot, the same will be demonstrated so as to be truly recorded, and hence warn the founder of injury which he may expect if he does arrange for good "feeding heads" and "feeding." Mr. Cairns states that "the cavities in the ends of the test bars can be made larger or smaller, according to the manner in which the iron is poured into them." This statement is correct, but with a little judgment and experience a man will soon attain high perfection in truly recording shrinkage, if there is such an element existing to any serious degree in the iron.

The Manufacture of Steel Tapes.

Whilst the knowledge of the main processes in connection with the manufacture of steel tapes is regarded as a trade secret, the following particulars, which are of a general character, will be of interest: After the rolled ribbons have been tempered and ground, in quantities of from one to two dozen at a time, they are laid upon an iron table 50 feet long, which has a standard on each side. The standards are of government length at 62° Fahr. The ribbons, placed on this table in lines parallel to the standards, are made fast at one end, and a strain of 12 pounds under a spring balance is applied at the other. They are then printed with a wash or varnish not affected by acid, and then etched in a diluted nitric acid bath —the graduation being covered by the wax is left in the original surface of the tape.—*The Practical Engineer.*

No More Croaking.

A society among merchants and traders out West has been formed, in which the members agree that they will not hold conversation about hard times, dull trade, small orders, slow collections, low prices of wheat, etc. The idea is an excellent one.—*Hardware.*

The striking clothing workers of Boston, and possibly other friends in New York, are contemplating a scheme that, on the face of it, always looks promising, but that has failed time and again. The scheme is a gigantic co-operative plan of manufacturing clothing that will dispense with what are called middlemen, who, it is claimed, absorb too great a share of the profits. In other words, the workers claim that the profits of the middlemen belong to them. Now, it is a fact that is well known by all observing people that under present conditions it is necessary to have salesmen as well as builders. This class—the sellers—the distributors, cannot be dispensed with so long as present conditions prevail, and such conditions do not seem likely to be made different, not at least for some years to come.

Still every such venture always carries with it a good deal of interest. In the end, if it is a better plan than the present one, it will work good.

There is in this no intention to prejudice the efforts of the striking clothing makers.

Just like all other cases of the kind, there will be interest in the outcome. There is much more in the matter of making and distributing than is understood.

It is said that a noticeable feature of the last few months is the extent to which the band re-saw is taking the place of the circular re-saw. With the ribbon blade there is, it is claimed, less friction and no heat, and consequently more and better work is turned out.

In our remarks about "Long vs. Short Connections to Indicators" last week, we, writing from memory, did our contemporary, *Power*, an injustice in saying that it had computed clearance at 10 per cent. instead of $\frac{1}{10}$ per cent. We should have said that the argument was based on the assumption that the clearance was 4 per cent., the real clearance being about $\frac{4}{10}$ of one per cent. The error is only one of degree, however, and does not affect the principle involved.

Ulrich Eberhardt, Jr., and Miss Emelene N. Eberhardt, of Newark, N. J., have recently returned home from a three-months tour through the principal cities of Europe. They report having been received in a very generous and hospitable manner by the leading tool builders of Scotland, England, Switzerland and Germany, the trip having been made for the continuance and promotion of the foreign business in the well-known Gould & Eberhardt automatic machine tools.

Dr. Thurston, whose work in relation to the steam engine is practically never ceasing, sends us, with compliments, a reprint of an article published in the *Journal of the Franklin Institute* in August, 1894. We are not certain how this may be obtained, but a letter inclosing a stamp for return postage will bring a reply, no doubt, from Dr. Thurston, whose address is Sibley College, Cornell University, Ithaca, N. Y.

According to a recently issued report, there were purchased in the United States last year for use on naval vessels, 42,190 tons of coal, at a cost of $178,163. Abroad, 52,146 tons were purchased for our navy at a cost of $462,192. Seventy-one per cent. of this was used for steaming purposes, the balance for auxiliary purposes.

Norbert B. Kates, of 58 W. Eighth street, Cincinnati, will shortly establish in New York a general export agency, and will give especial attention to trade in South America, where he has successfully represented a number of American machinery builders, who speak highly of his success.

Since our report of the performance of the armored cruiser "Maine," published last week, computations have so far progressed as to indicate that the engines developed during the trial 9,229 horse-power, or 229 horse-power above the requirements, which, at $100 premium per horse power, will give the builders of the engines $22,900 extra. It is reported that the naval engineers aboard the vessel declare that considerably more power could have been obtained by better management of the engines on behalf of the builders.

As an illustration of the effect of marine and vegetable growths that attach themselves to the hulls of naval vessels, especially in tropical waters, the commander of the "Bennington" reports that that vessel, with a clean hull, steamed from Acapulco to La Libertad, 675 miles, at the rate of 7.85 knots an hour on a coal consumption of 67 tons. Two months later she ran back, 688 miles, at only 6.2 knots per hour, and consumed 129 tons of coal, the excess being due entirely to the fact that she had to drag through the water a vast accumulation of marine growths which there was no means of clearing off without docking the ship.

The man near Cincinnati, who, when a fire started in his house, closed it and refused to admit the firemen on the ground that he *knew* his house was fireproof, lost his house and its contents, and proved that he was woefully ignorant of so-called "fireproof" constructions.

If he had been in New York his experience might have been more fortunate, because the firemen certainly would have gone into his house and fought the fire in spite of his objections. This was shown in the case of a small fire which occurred in one of the fine houses of the city, and where, an alarm having been turned in, the firemen on arriving were met at the door by a pompous flunkey, who told them the fire had been put out, and that his master did not wish to be disturbed. It was then found that the firemen considered it part of their business to investigate for themselves, every fire, and they went into the house willy-nilly and chopped up the floor, and satisfied themselves that the fire was out, a practical illustration of the fact that neighbors, insurance companies, and, in short, the public generally, are interested in fires.

The *Pittsburgh Times* seems to know what it is that builds up and makes prosperous cities and what has the opposite effect, when it declares that the question of exempting machinery from taxation is one worthy of consideration by the next legislature, and then adds, "If a reduction in the tax burden upon properties which have some share in making the city's prosperity could be counter balanced by an increased tax on unimproved properties, and thus discourage the withholding of large tracts from sale and improvement, it might be a double blessing. It would be pretty certain to make building lots cheaper."

In our issue of October 11th the columns *W* in the table on page 7 should have decimal points instead of commas.

MANUFACTURES

An electric-light plant will be established at Frenchtown, Pa.

An electric-lighting system will probably be established at Springfield, Tenn.

The Cummer Company will establish a large planing-mill plant at Norfolk, Va.

The Cascade Knitting-mill on Van Schaich Island, Cohoes, N. Y., is being enlarged.

Pierce City and Monett, Mo., will probably be connected by an electric railway system.

C. M. Rubush is about to commence the erection of the new electric light plant at Meridian, Miss.

The Erie shops at Hornellsville, N. Y., are reported to be running full time, and some of the men are working over time.

The Springfield Machine Tool Co., Springfield, O., write us that trade is improving in a steady healthy manner, and that their foreign trade is increasing.

The Buffalo Forge Co., Buffalo, N. Y., report considerable business in putting in ventilating fans and other apparatus in school buildings throughout the country.

August H. Tuechter, who manages affairs for the Bickford Drill and Tool Co., of Cincinnati, was in this office a few days ago, and reports business much better during the past six weeks than formerly.

The Carrie Furnace Company, of Pittsburgh, have advanced the wages of laborers from $1.05 to $1.20 per day, and it is believed that others in Pittsburgh, who are now paying less than $1.20, will advance wages.

We have received from the Lodge & Shipley Machine Tool Co., Cincinnati, O., a small pamphlet devoted especially to their improved lathe, which we illustrated and described a short time ago. The pamphlet is sent upon application.

A NEW EDITION.

We are just printing the second edition of our "Engineers Epitome." [Price 50 cents, postpaid.]

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I have received the "Epitome" and am well pleased with it. It is the best book for the money I ever saw. J. B. PETERIE, Old Victoria Mines, Cape Breton, N. S.

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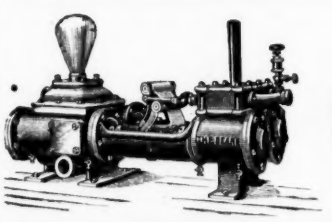

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We have received from Mitts & Merrill, Saginaw, Mich., an illustrated catalogue of the giant key seater, and giving perspective and outline illustrations of various sizes and styles of the machine with tables and other information.

The Metropolitan Street Railway Co., of New York, will erect in Seventh Avenue the largest car house in the world. It will cover nearly a block, and will be five stories high, of steel, brick and granite. Elevators will be put in to take cars up and down from the upper floors.

We have received from M. C. Huyett, Heating and Ventilating Engineer, Monadnock Building, Chicago, Ill., a pamphlet entitled "Mechanical Heating and Ventilation." It is illustrated, and contains tables and other matter of value and interest to those who are interested in heating or ventilation of buildings of any kind.

We have received from the Star Dynamo Co., Jefferson City, Mo., an illustrated catalogue of dynamos, designed especially for use in isolated or private plants, and for lighting mills and factories already equipped with power, and in which 4 to 15 horse-power, according to the number of lights wanted, can be spared for the purpose. The pamphlet is sent to those interested upon application.

We have received from the David Maydole Hammer Company, Norwich, N. Y., an elegantly printed and illustrated catalogue of hammers for practically all the purposes for which hammers are used. The name of Maydole has so long been associated with hammers and their manufacture, and the catalogue gives such full information regarding the Maydole hammers, that it will no doubt prove of value to all who are interested in them.

We have received from the Weber Gas and Gasoline Engine Co., Kansas City, Mo., a "standard size" catalogue illustrating and describing various forms and sizes of the Weber gas and gasoline engine, which is adapted to be used for all the purposes for which such engines are ordinarily used, and especially where small power plants are required. It is built both horizontal and vertical, and is used successfully for driving dynamos for electric lighting.

Some indication as to the state of business is given by the fact that during a recent trip by John J. Grant—a trip confined to a few of the Central States, and lasting six weeks, he took eleven orders for automatic screw machines made by the Cleveland Machine Screw Co., the eleven orders aggregating 52 machines. It also shows, incidentally, what a thorough mechanic who is familiar with manufacturing operations may do as a machinery salesman, occasionally.

The Foster Engineering Co., of Newark, N. J., report that among recent orders received for their pressure regulators to be applied to dynamo engines are two 4-inch for the U. S. battle-ship "Texas"; one 5-inch for the U. S. armored cruiser "Brooklyn"; one 3-inch and one 4-inch for the U. S. armored cruiser "Indiana"; five 7 inch for the Providence Steam Engine Co.; two 8-inch for the Corliss Engine Co., of Providence, and one 4-inch for the Western Union Telegraph Company's building. The latter is to deliver steam to three dynamo engines, and to meet specifications, is required to maintain within one pound a uniform delivery pressure of 45 pounds, regardless of change of initial or boiler pressure, which ranges from 60 to 100 pounds, and regardless of change of load or number of engines in operation.

The Tradesman, Chattanooga, Tenn., in its report on the industrial condition of the South for the week ending October 22d, says: The output of pig-iron continues on a large scale, and prices are fairly well maintained. While no large transactions are reported, the aggregate of medium and small orders is sufficient to prevent accumulation of stocks in the yards. The Southern coal operators are doing a satisfactory amount of business. The lumber market is slowly improving as to prices, and the good effects of associations of manufacturers are beginning to be seen. Low priced cotton is preventing an increase in the volume of mercantile business. Money is easy but collections are somewhat slow. *The Tradesman* reports 38 new industries as incorporated or established during the week, prominent among which are: The Roanoke Rapids Power Co., of North Carolina, capital $2,000,000; a $200,000 brewery at Jacksonville, Fla.; a 500-barrel flouring mill, 200 barrel corn mill, elevator, etc., at Houston, Texas, and a $100,000 fertilizer factory at Spartanburg, S. C. Car works with $100,000 capital are reported at Fort Worth, Texas; a $50,000 medicine company, at Hillsboro, Texas; a $25,000 lumber company at Stuttgart, Ark; one with $20,000 capital at Taylor, Texas: cotton mills at Carrollton, Ga., and Morganton, N. C., and a $10,000 tannery at Buford, Ga. Brick works are to be established at Kinston, N. C.; an electrical plant at Greenup, Ky.; flour and grist mills at Huntland and Kettle Mills, Tenn., and foundries and machine shops at Elberton, Ga., Alexandria, La., and Huntington, W. Va.; ice factories will be built at Jacksonville and Lakeland, Fla., and Patterson, La.; oil mills at Alexander City, Ala., and Morrilton, Ark., and woodworking plants at Glendon and Jemison, Ala., Tampa, Fla., Tallapoosa, Ga., High Point and Flat Rock, N. C., Hattiesburg, Miss., Jackson, Tenn., Taylor, Texas, and Moundsville, W. Va. Water-works are to be built at Abbeville, Augusta and Dawson, Ga., Lexington, Ky., and Brenham, Texas.

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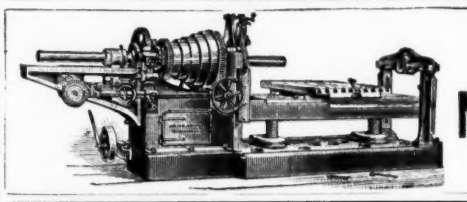

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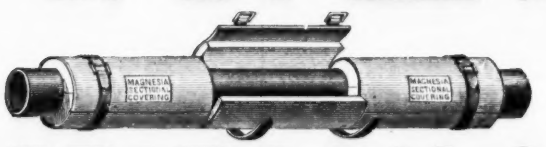

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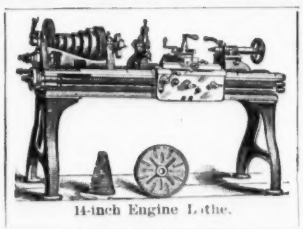
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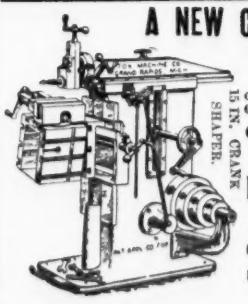

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Best Steel Flue Scrapers. Kelley Co., Erie, Pa.

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Radial Drills 54 and 66 in.
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Lincoln Pattern, very cheap.
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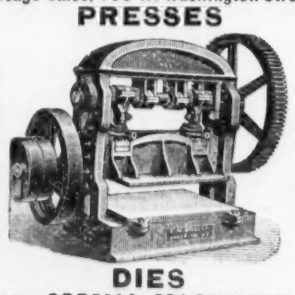

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Hor. Flange Punch No. 2 H. & J. Thomson Bevelling Shear.
15 " 6 and 8 ft. Eng. Lathe.
16 " 5 6, 7 and 10 ft. Eng. "
18 " 6 7 and 8 " " "
20 " 5, 6, 7, 8 and 10 ft. " "
21 " 10 and 13½ ft. " "
24 " 10 " " "
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32 " 16 " " "
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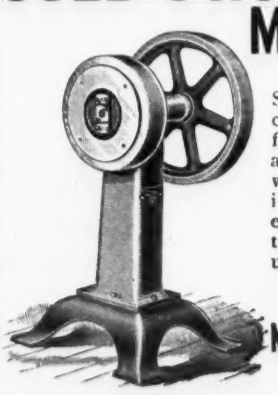

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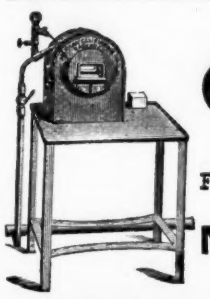

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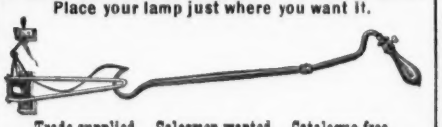

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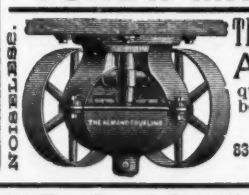

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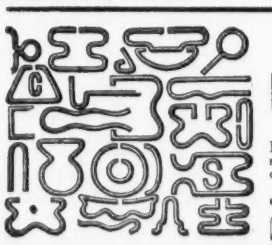

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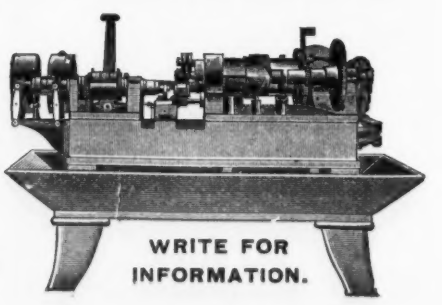

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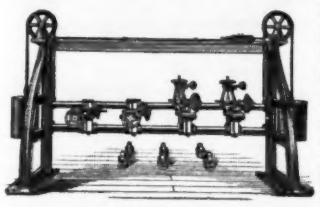

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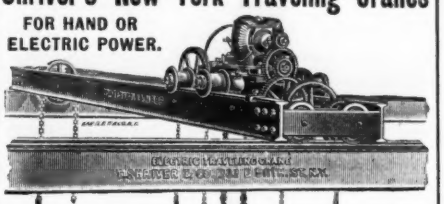

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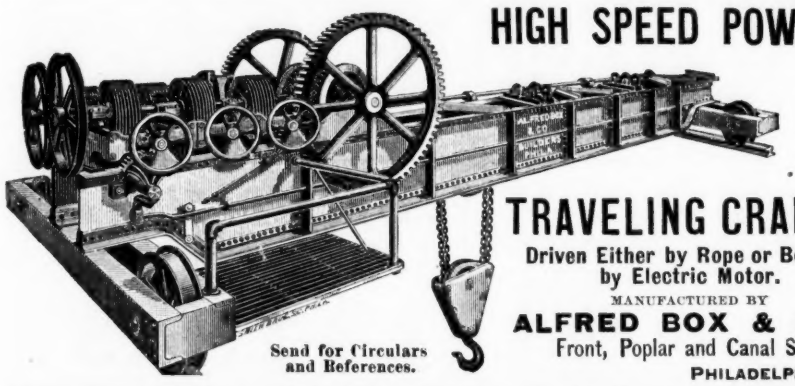

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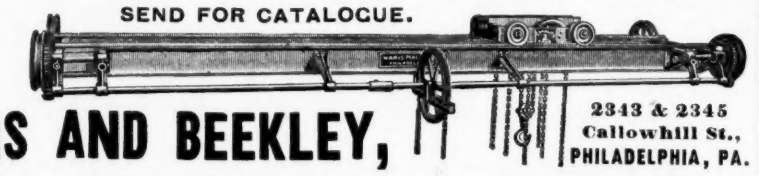

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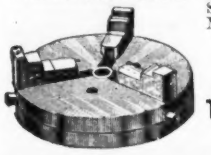

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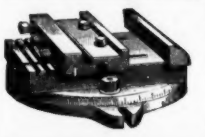

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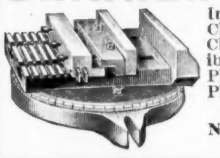

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Boiler Room Accidents, W. H. WAKEMAN.
Peculiar Locomotive Explosion.
In a Modern Shop, FRED H. COLVIN.
The Slide Rule in the Shop, WILLIAM COX.
Forced vs. Natural (?) Draft, PETER H. BULLOCK
A Few Shop Kinks, JOHN T. USHER.
Designing Stationary Engines (2), THEO. F. SCHEFFLER, JR.
Resistance of Trains of Mechanism (2), LEICESTER ALLEN.
Hints for Machinists and Engineers, JAMES F. HOBART.
Various Short Articles of Interest. What Mechanics Think.

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"Machinery" is the name of a new monthly that comes to us from 411-413 Pearl Street, New York. It is edited by Fred H. Colvin. The initial number contains 14 pages of reading matter, and is illustrated with several photo-engravings.*

As we want the readers of the *American Machinist* to compare MACHINERY with this description and see if it fits, we will mail a copy of the current issue free to any one who sends his name and address to

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* The September number, to which this refers, contained 173¼ pages of reading matter, 15 half-tone and 18 line engravings—33 in all, and 18 original articles, long and short. It was printed on enamelled paper with cover of three colors. Fifty of the ablest mechanical writers of the day comprise the list of contributors. But the most essential feature overlooked by our contemporary was the price—Fifty cents a year for domestic subscriptions, Seventy-five cents a year for foreign.

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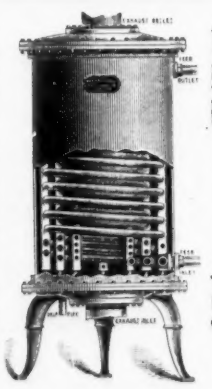

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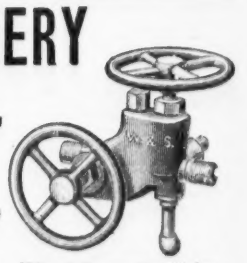

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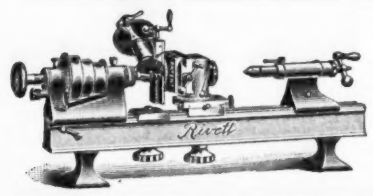

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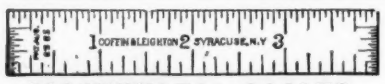

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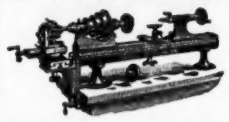

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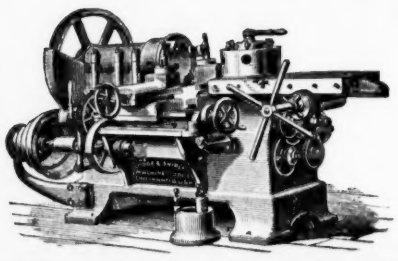

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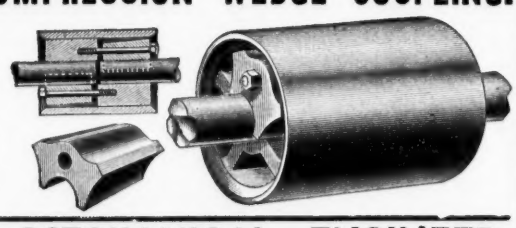

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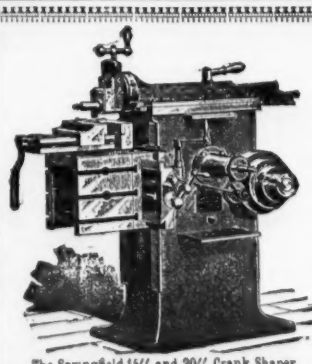

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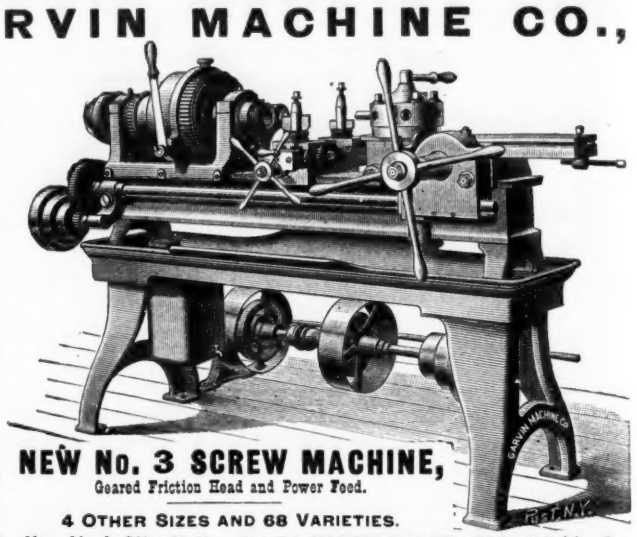

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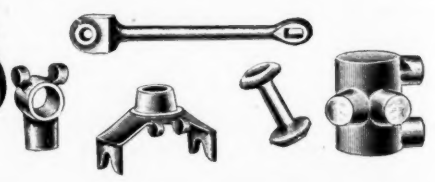

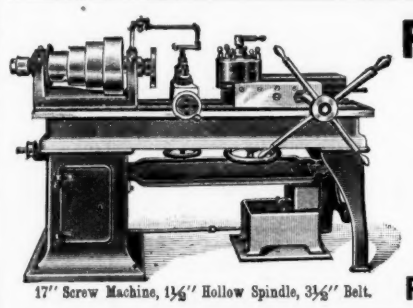

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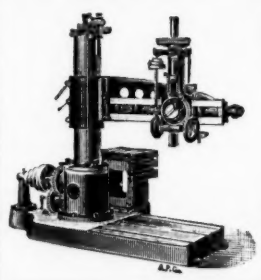

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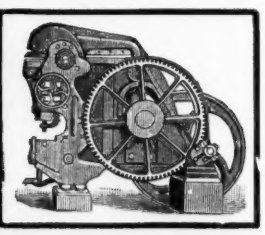

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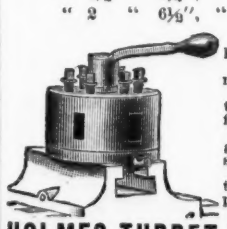

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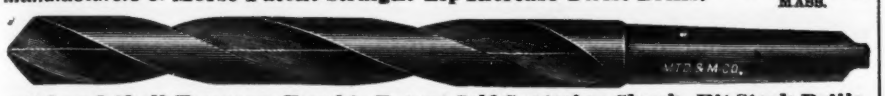

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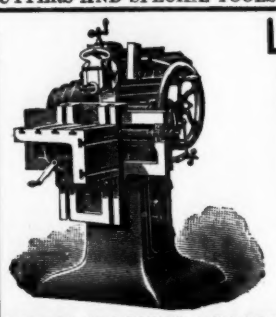

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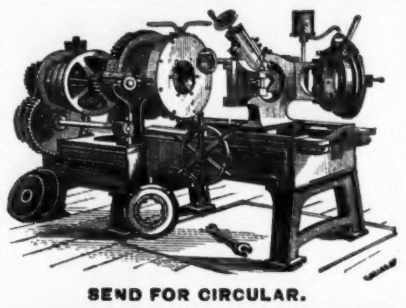

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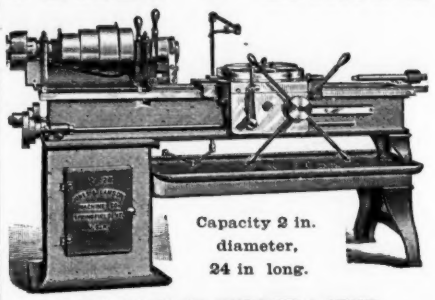

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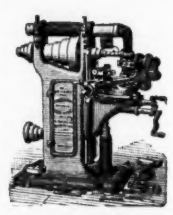

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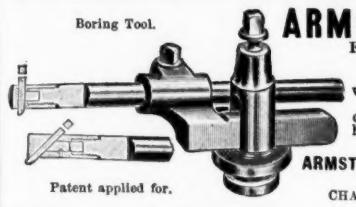

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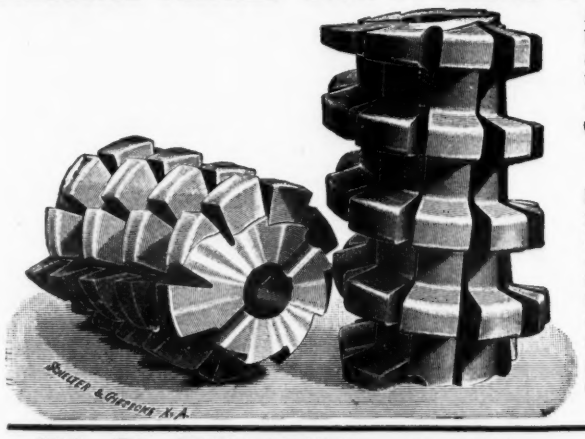

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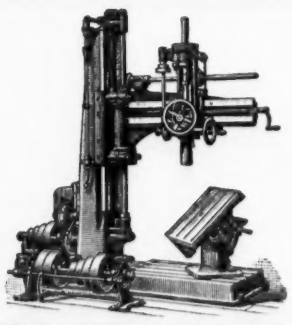

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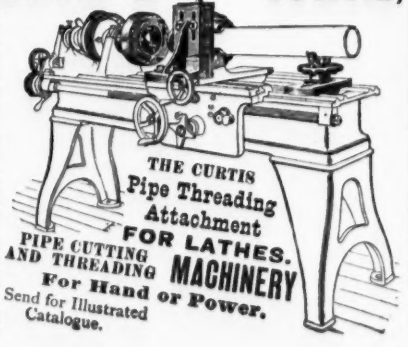

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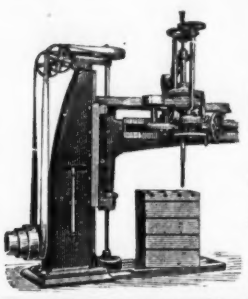

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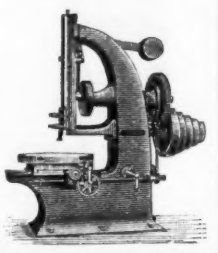

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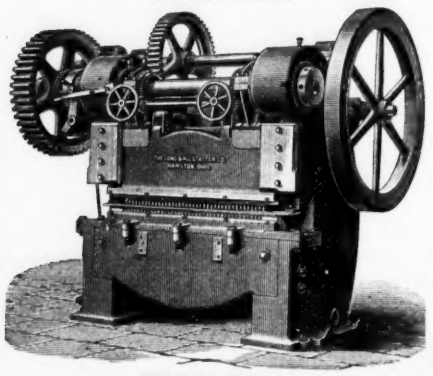

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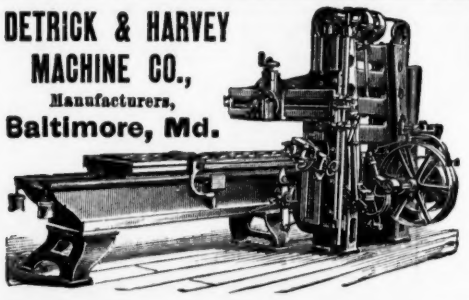

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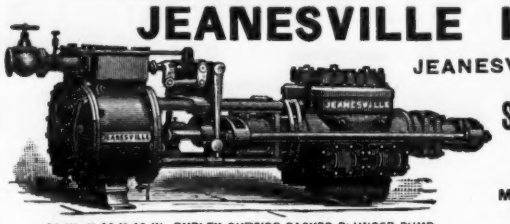

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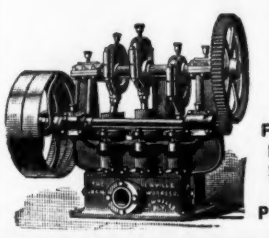

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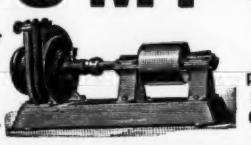

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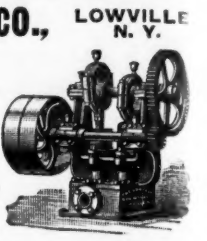

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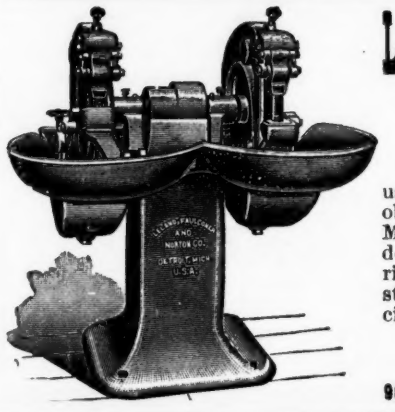

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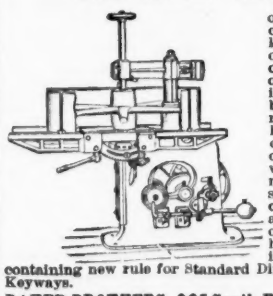

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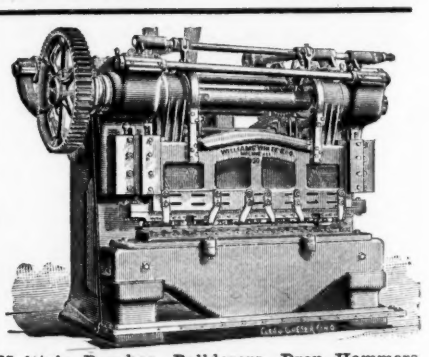

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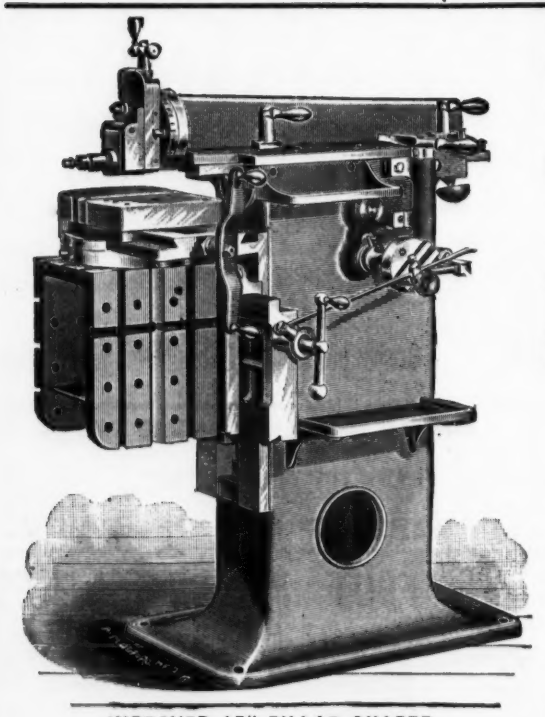

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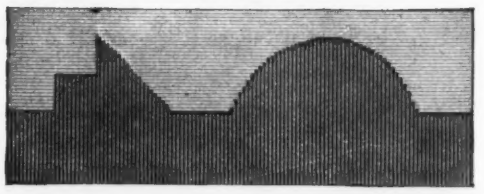

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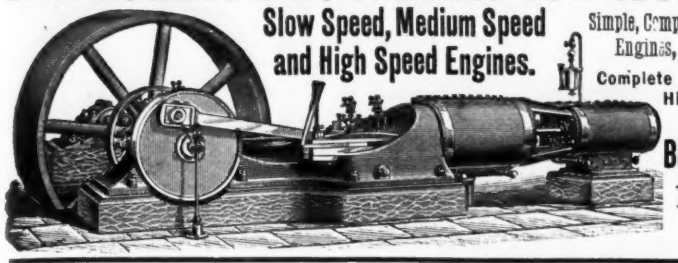

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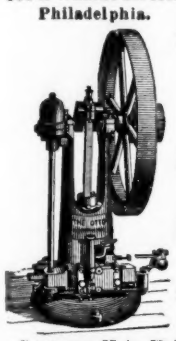

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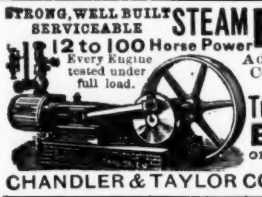

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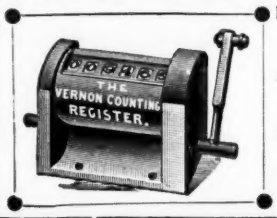

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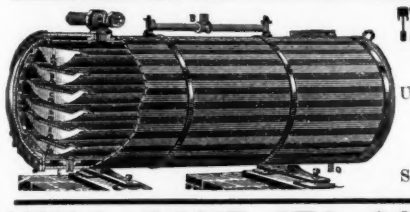

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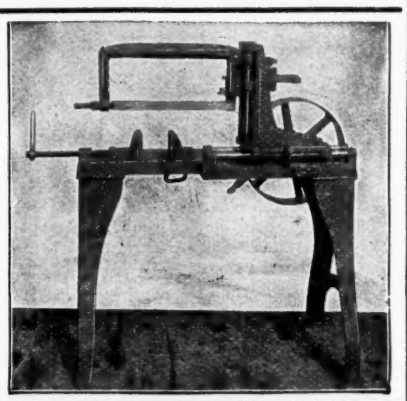

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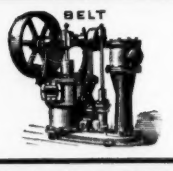

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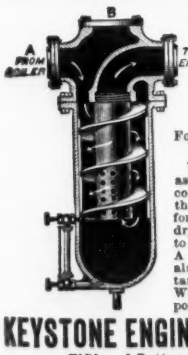

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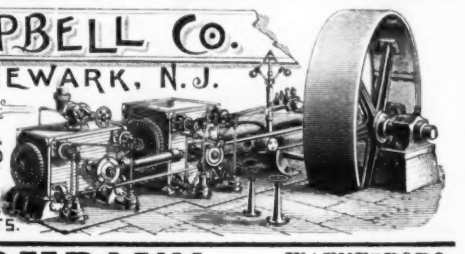

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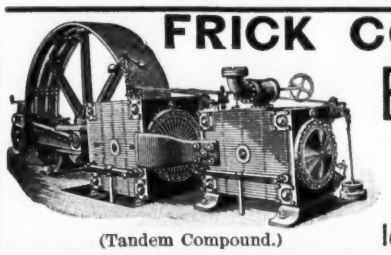

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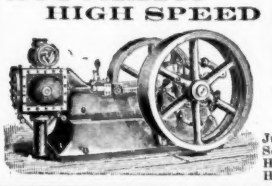

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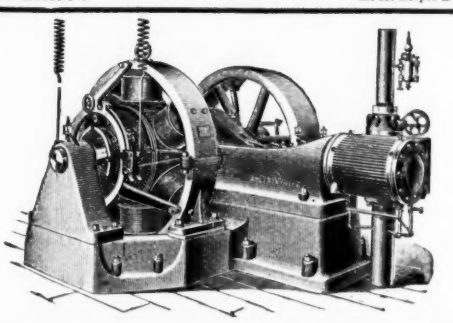

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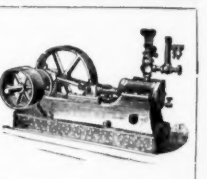

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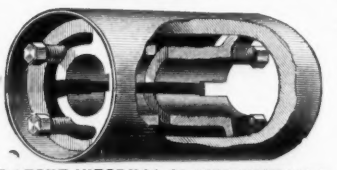

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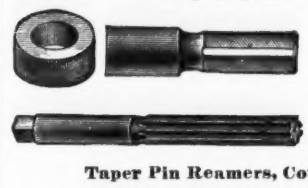

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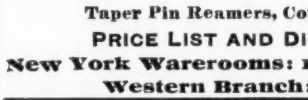

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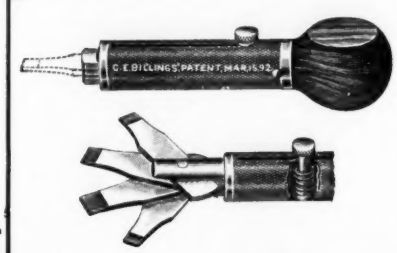

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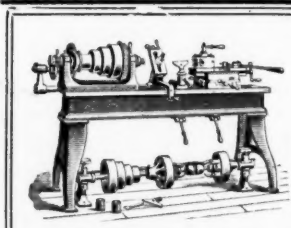

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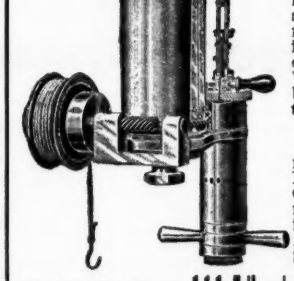

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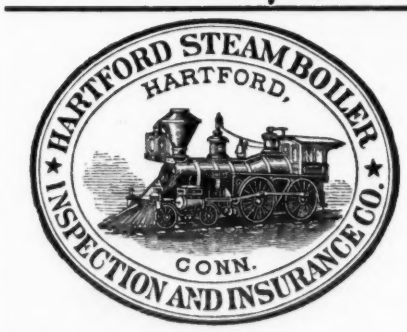

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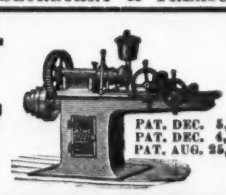

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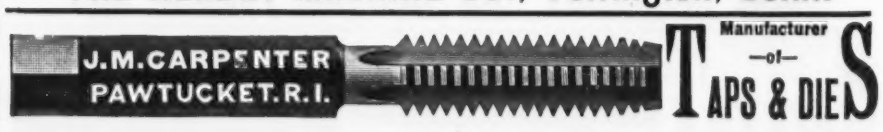

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